

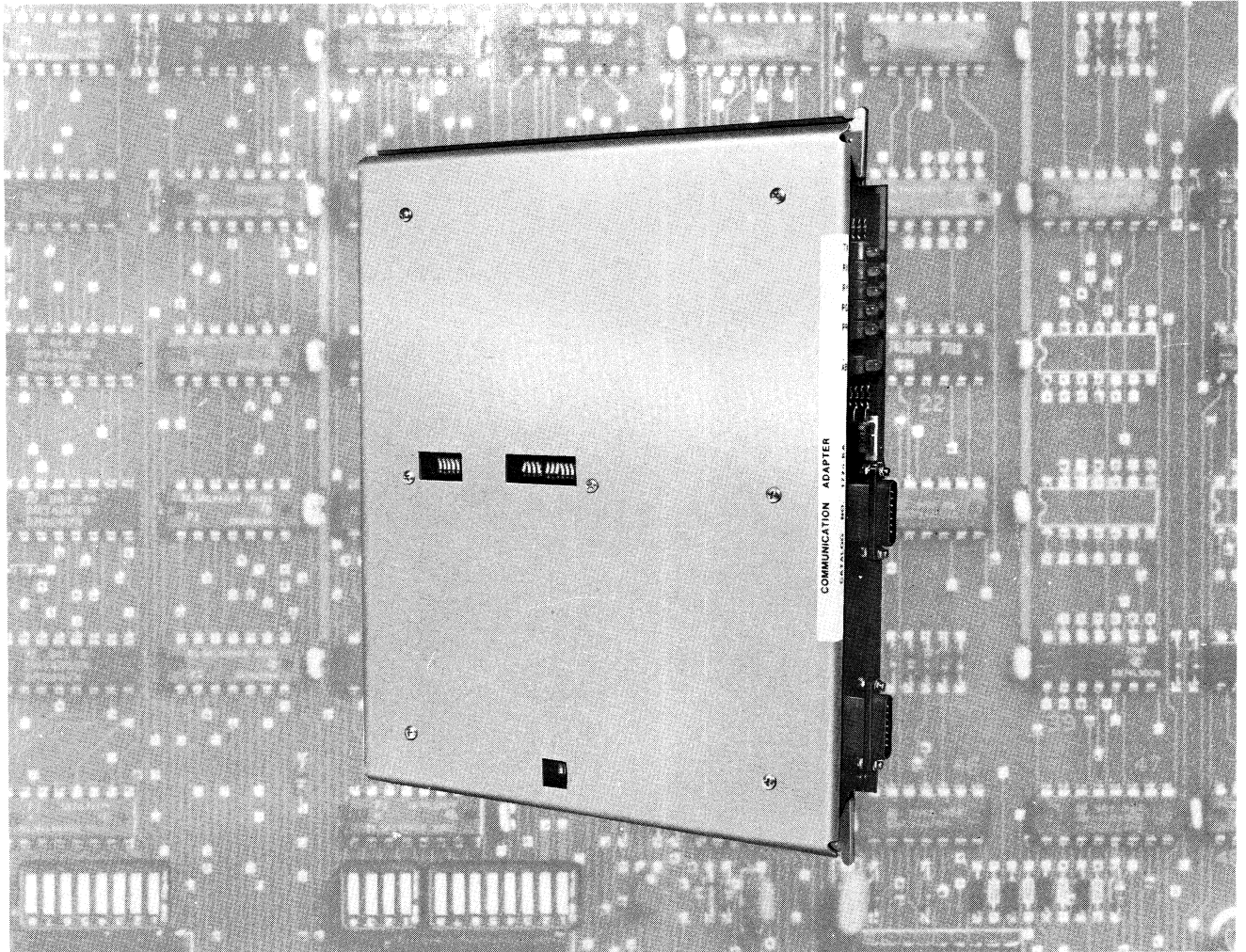
**1774-819**

**Bulletin 1774**

# **COMMUNICATION ADAPTER**

**(Cat. No. 1774-KA)**

## **User's Manual**



**ALLEN-BRADLEY**  
Cleveland, Ohio 44143

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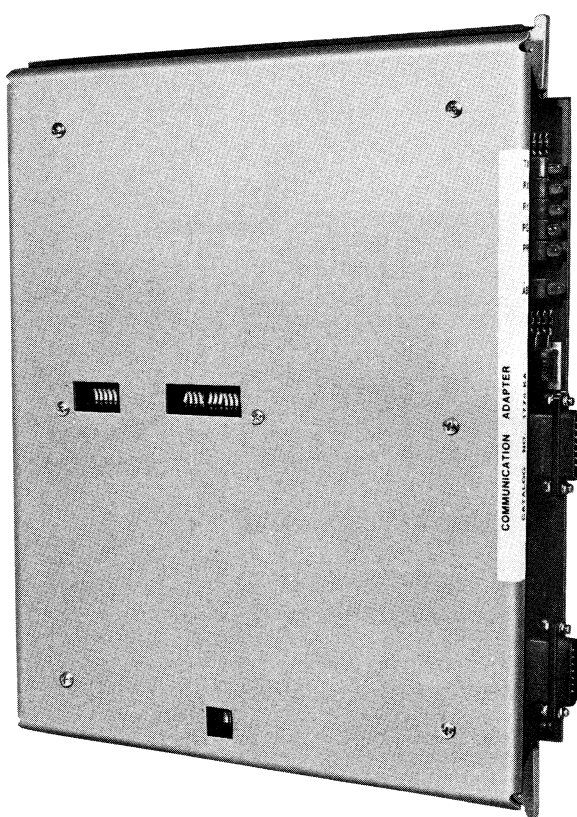
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## Section 1 INTRODUCTION

### 1.0 DESCRIPTION

The Allen-Bradley Data Highway extends the capability of control of the Programmable Controller. Using the Data Highway, discrete Programmable Controllers can communicate data to each other and with a computer. Thus, the Data Highway allows the integration of individual controllers into a larger automated manufacturing network. On a single Data Highway Cable, as many as 64 separate Programmable Controllers and computers can be connected over a distance of up to 10,000 feet.

The Communication Adapter Module (Cat. No. 1774-KA) is the Data Highway station interface Module for use with Bulletin 1774 PLC Programmable Controller Processors. (Refer to Figure 1-1.)



**FIGURE 1-1 — Communication Adapter Module  
(Cat. No. 1774-KA)**

This Module enables communication of memory data between PLC Processors and from any of these Processors to a Bulletin 1772 PLC-2/20 or PLC-2 Processor or Mini-Processor Module, connected through a Communication Adapter Module (Cat. No. 1771-KA), or to a computer, connected through a Communication Controller Module (Cat. No. 1771-KC, -KD).

A typical Data Highway configuration is shown in Figure 1-2.

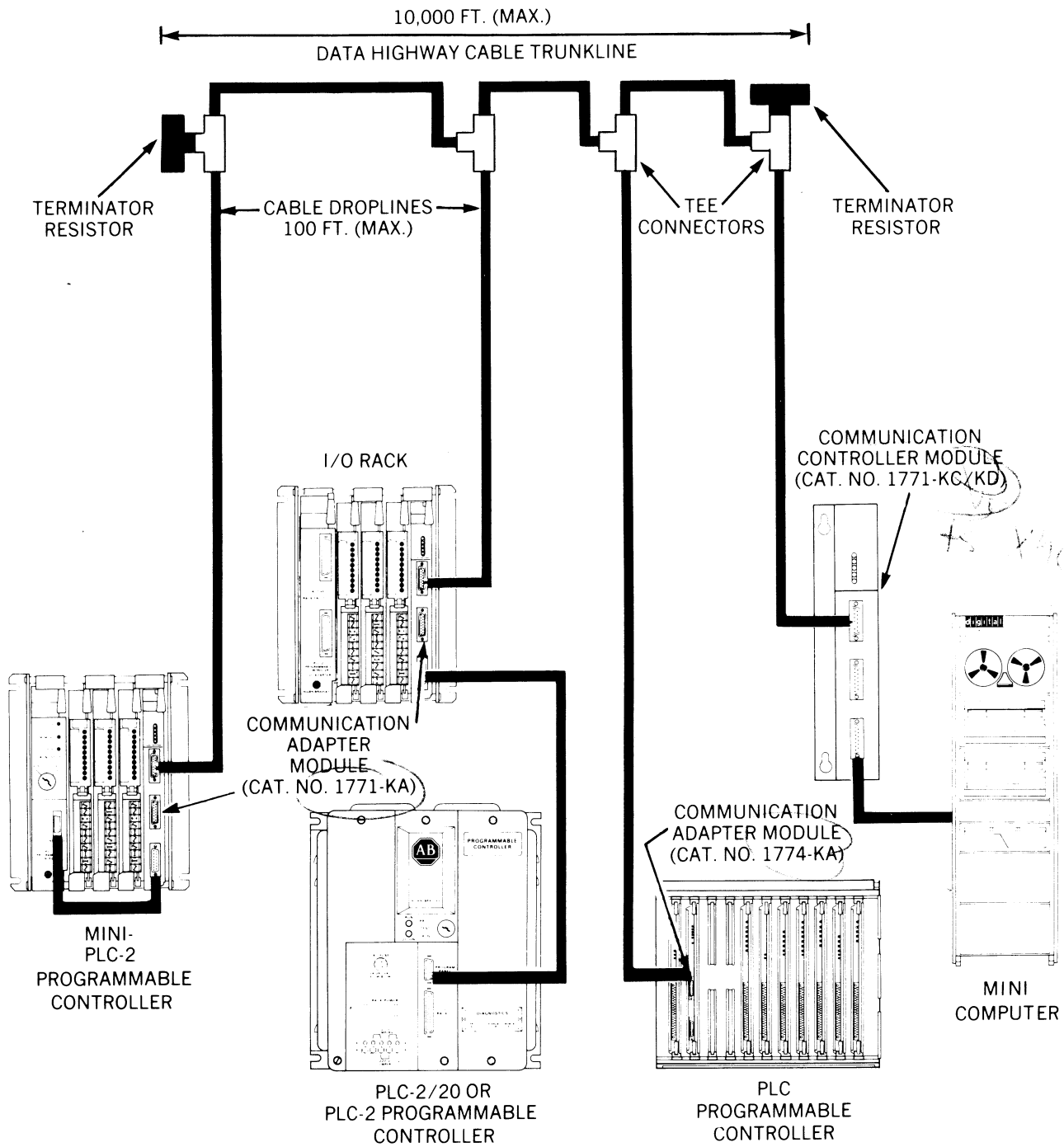
### 1.1 ABOUT THIS MANUAL

This Manual describes the installation, operation, and programming necessary to use the Communication Adapter Module (Cat. No. 1774-KA). It is intended that this Manual be used in conjunction with the other Manuals and Publications which are pertinent to the user's individual Data Highway configuration. Table 1-1 lists the Data Highway Manuals which are currently available.

**TABLE 1-1 — Data Highway Documentation**

| PUBLICATION NUMBER | TITLE                                                                |
|--------------------|----------------------------------------------------------------------|
| 1771-801           | User's Manual, Communication Adapter Module (Cat. No. 1771-KA)       |
| 1774-819           | User's Manual, Communication Adapter Module (Cat.No. 1774-KA)        |
| 1771-802           | User's Manual, Communication Controller Module (Cat. No. 1771-KC/KD) |
| 1770-810           | Data Highway Cable, Assembly and Installation Manual                 |

In order to use this Manual, a knowledge of the particular Programmable Controller being used in an application is essential. Because the Communication Adapter Module is connected to an operating Programmable Controller, it



**FIGURE 1-2 — Representative Data Highway Configuration**

must be assumed that the user has a good understanding of Programmable Controller operation, installation, memory structure, and programming.

Publications are available on each of the currently available Allen-Bradley Programmable Controllers. Table 1-2 lists the Manuals which describe these Programmable Controller products.

## 1.2 ORGANIZATION

Subsequent Sections of this Manual are organized as follows:

- Section 2 describes the hardware components which make up a Data Highway station.
- Section 3 outlines the procedures for Module installation.
- Section 4 describes programmed commands and memory access.
- Section 5 describes the programming of the Communication Zone of program.
- Section 6 describes status words which are controlled by the Module at its station Processor.
- Section 7 outlines the programming that is necessary to initiate and monitor command execution.
- Section 8 describes station interface Module interaction along the Data Highway.
- Section 9 describes start-up and troubleshooting tools and procedures.
- Section 10 provides aid to design and documentation of a Data Highway station using the Communication Adapter Module.

**TABLE 1-2 — Manuals for Current Programmable Controllers**

| CONTROLLER                         | PUBLICATION NO. | MANUAL TITLE                      |
|------------------------------------|-----------------|-----------------------------------|
| Mini-PLC-2 Programmable Controller | 1772-820        | Assembly and Installation Manual  |
|                                    | 1772-821        | Programming and Operations Manual |
|                                    | 1772-820-1      | Support Documentation             |
| PLC-2 Programmable Controller      | 1772-800        | User's Manual                     |
|                                    | 1772-800-1      | Support Documentation             |
| PLC Programmable Controller        | 1774-812        | Assembly and Installation Manual  |
|                                    | 1774-800        | Programming and Operations Manual |
|                                    | 1774-800-1      | Support Documentation             |
| PLC-2/20 Programmable Controller   | 1772-801        | Assembly and Installation Manual  |
|                                    | 1772-801-1      | Support Documentation             |
|                                    | 1772-802        | Programming and Operations Manual |

## Section 2 STATION HARDWARE

### 2.0 GENERAL

The following components make up a Data Highway station for a PLC Programmable Controller:

- Communication Adapter Module (Cat. No. 1774-KA)
- PLC Processor (Cat. No. 1774-LP1, -LP2, -LP3, -RP1, -RP2, -RP3, -RP4)
- Data Highway Cable dropline and associated hardware

Figure 2-1 shows the configuration of a Data Highway station of this type.

The term “station”, as used in this Manual, encompasses both the Communication Adapter Module and the PLC Processor in which the

Module is mounted. In subsequent descriptions, where it is necessary to differentiate these units, the term “station Processor” or “station Communication Adapter Module” is used.

The following Paragraphs describe each unit of the Data Highway station and its function.

### 2.1 COMMUNICATION ADAPTER MODULE

The Communication Adapter Module (Cat. No. 1774-KA) provides the interface between the PLC Processor and other stations on the Data Highway. (Refer to Figure 2-2.) An optional Processor Module, the Communication Adapter Module can be installed in slots 0, 1, 2, or 3 of the PLC Processor Chassis for current PLC Processors (Cat. No. 1774-LP3, -RP3, -RP4).

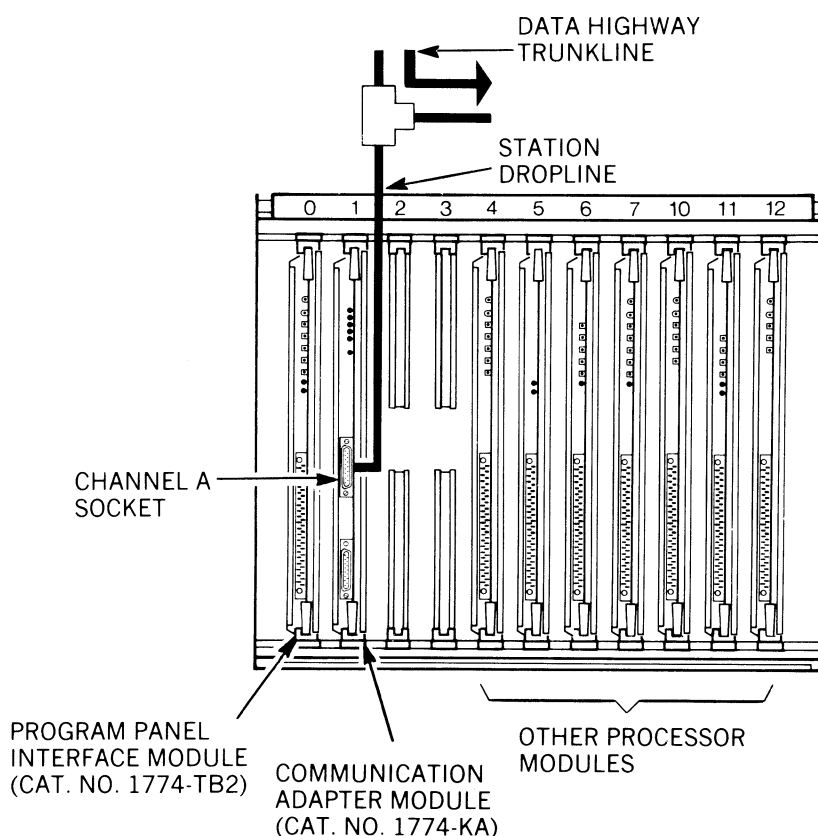
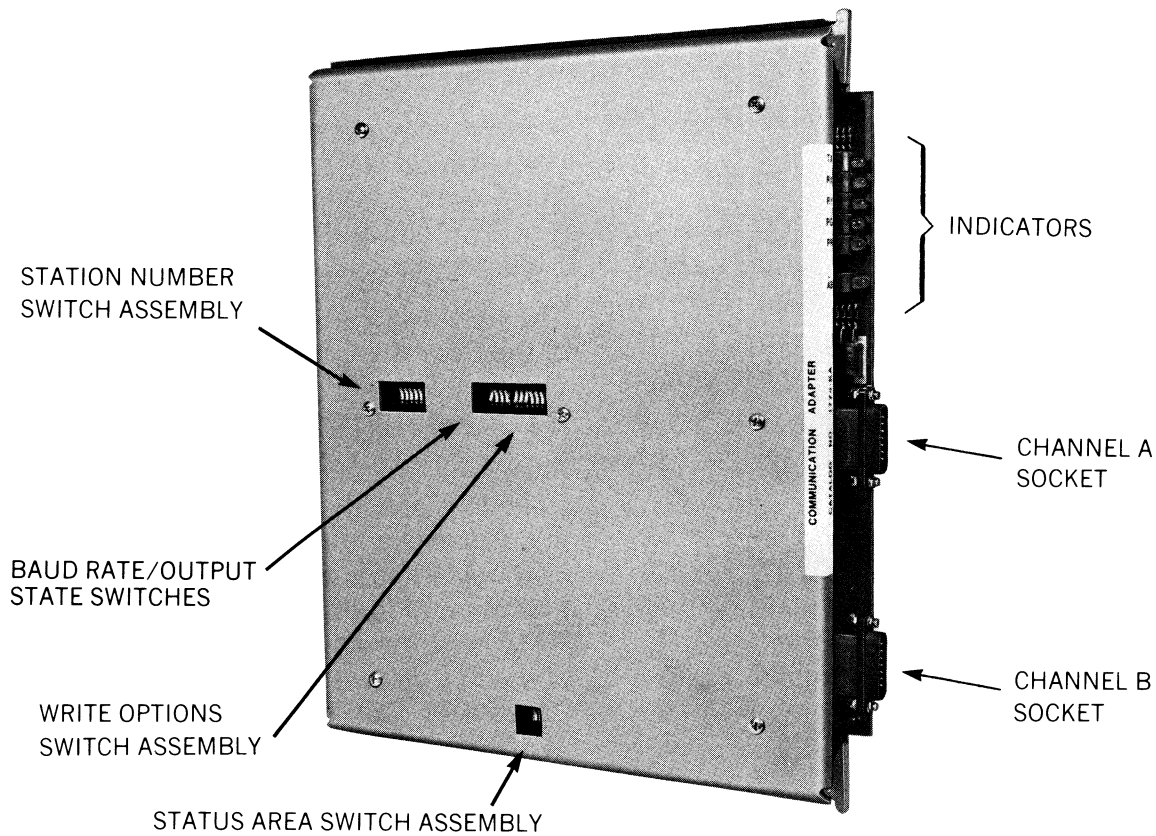


FIGURE 2-1—Station Configuration — PLC Processor



**FIGURE 2-2 — Communication Adapter Module (Cat. No. 1774-KA)**

For PLC Processors with Cat. No. 1774-LP1, -LP2, -RP1, or -RP2, this Module can be placed in slots 0 or 1 of the Processor Chassis. As an optional Processor Module, the Communication Adapter Module can be used in a PLC Processor at the same time other optional Modules, such as the Program Panel Interface or Data Handling Module, are used.

On the Communication Adapter Module are sockets for cable connection, switches for the selection of certain Module capabilities and control of the Processor Status Area, and indicators to aid in monitoring Module behavior and in troubleshooting. Subsequent paragraphs describe the function of each of these areas.

Each Communication Adapter Module in a Data Highway installation has a unique identifying Station No., switch-selected on the Module. This Station No. is used to address commands to the Module from other stations. Should multiple Communication Adapter Mod-

ules be used in a single PLC Processor Chassis, each of these Modules must have a different Station No.

### 2.1.1 Sockets

There are 2 sockets on the front of the Module. These sockets are:

- CHANNEL A
- CHANNEL B

Channel A is used for the connection of the Module to the Data Highway Cable dropline, as shown in Figure 2-1. Through this connection, a single Communication Adapter Module can communicate with as many as 63 other Data Highway stations.

Module transmitting and receiving circuitry on Channel A are transformer-coupled to the Data Highway link. This design permits differential transmission of data with high common-mode noise immunity. Electrically, transformer coupling provides a high degree of isolation be-



tween Module logic circuitry and the Data Highway Cable.

A reed relay on the Module connects transmitting and receiving circuitry on this channel to the Data Highway communication link. Should Module diagnostics detect faulted Communication Adapter Module operation, these relay contacts are opened, disconnecting the Module from the Data Highway. This arrangement is designed to remove a station from the Data Highway communication link when it is "hogging" or failing to relinquish mastership due to a fault in transmission circuitry. The operation of this feature is described more fully in Section 8.

Channel B is a redundant channel which provides the same features as the Channel A socket. However, both channels cannot be active at the same time. Module circuitry allows only one channel to be active at any time, normally, Channel A.

To enable Channel B, the user must jumper DC power to specific pins at the Channel A or Channel B socket. This type of arrangement can be used to switch the Module onto a redundant Data Highway Cable if a fault is detected. (Note, however, that only one of these channels is active at a time.) For further information on this type of redundancy arrangement, contact Application Engineering, Programmable Controller Systems Division, Allen-Bradley Co.

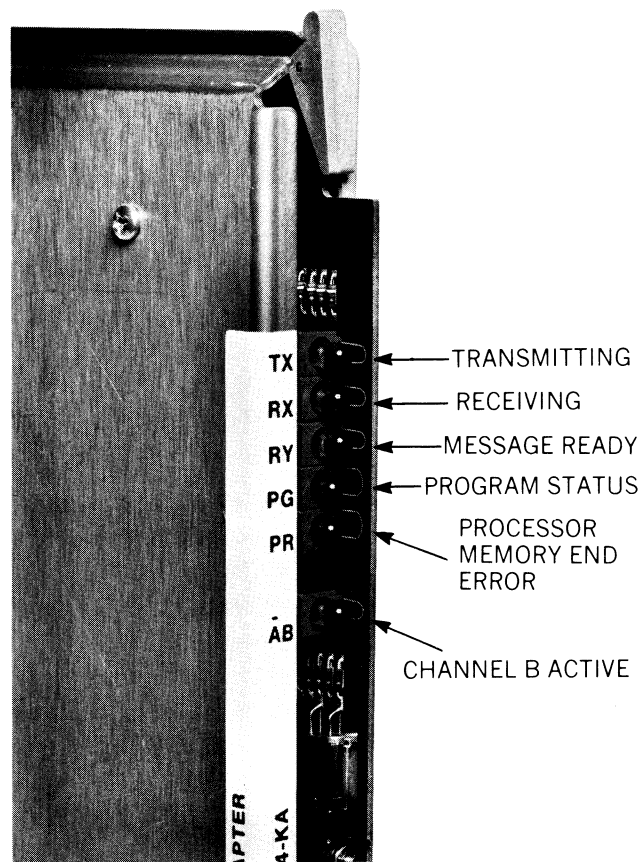
A Module indicator illuminates when Channel B is active.

### 2.1.2 Indicators

Refer to Figure 2-3. There are 6 LED indicators on the front of the Module. These indicators are labeled:

- TX — Transmitting
- RX — Receiving
- RY — Message Ready
- PG — Program Status
- PR — Processor Memory End Error
- $\overline{AB}$  — Channel B Active

These indicators are useful for monitoring



**FIGURE 2-3 — Module Diagnostic Indicators**

Module activity and troubleshooting. The 4 green indicators show Module status during normal receiving and transmitting of messages. The 2 red indicators show the status of Module diagnostics.

#### TX

The green Transmitting indicator, labeled TX, turns ON when the Module is current master of the Data Highway. When this indicator is ON, therefore, the Communication Adapter Module is transmitting messages on the Data Highway communication link.

#### RX

The green Receiving indicator, labeled RX, turns ON when the Module is receiving a message addressed to it. Otherwise, this indicator is OFF.

Note that when both the RX and the TX indicators are ON, the Module is current master of the Data Highway and is polling. (Polling procedure is described in Section 8.)

## **RY**

The green Message Ready indicator, labeled RY, turns ON when the Module has messages which it is ready to transmit. With this indicator ON, the Module is ready to assume mastership when it is polled.

## **PG**

The red Program Status indicator, labeled PG, indicates the status of the Module checks on the Communication Zone rungs of the user program. (These rungs are described in Section 5.)

The Module first checks these rungs at power-up. When it locates the Header rung of this Zone, the Module turns the PG indicator ON. After it checks these rungs, provided that no errors are found, the Module turns this indicator OFF. However, should any programming error be detected in the Communication Zone of program, this indicator remains ON. In this event, the Module cannot function. The Communication Zone of program must be checked and any errors corrected. (Start-up procedures are described in Section 9.)

Should this indicator blink ON and OFF continuously, a discrepancy in Station No. switch setting has been detected. (Refer to paragraph 3.1.4.)

## **PR**

The red Processor Memory End Error indicator, labeled PR, indicates the status of the Module interaction with other optional PLC Processor Modules. Specifically, this Module interaction refers to control of the 9-word Status Area at the end of the Processor memory. (This subject is described in paragraph 2.2.1.)

When the PR indicator is ON, an error in control of the Status Area has been detected. The outputs of the local station Processor are disabled and Module communication with the station Processor may be inhibited. Should this happen, a change in the user program or in a Module switch setting may be required. (Refer to paragraph 2.2.1.)

## **AB**

The green Channel B Active indicator, labeled AB turns ON only if the Channel B socket on

the front of the Module is active and communicating with the Data Highway. (The Channel B socket is the lower socket on the front of the Module.) Normally the Channel A socket is used and this indicator is OFF.

### **2.1.3 Switches**

Refer to Figure 2-2. There are several sets of switches on the Communication Adapter Module circuit board. The settings of these switches allow the user to select various Module communication functions and capabilities. Switch-selected options include:

- Command capabilities
- Last-state control of controller outputs during program loading from a host computer
- Station No. of the Module
- Memory status word control when used with other optional PLC Processor Modules
- Data Highway communication rate (normally 57.6k baud)

Switch setting is a part of Module installation, described in Section 3.

### **2.1.4 Module Specifications Summary**

Operating specifications for the Communication Adapter Module (Cat. No. 1774-KA) are shown in Table 2-1

## **2.2 PLC PROCESSOR**

As an optional PLC Processor Module, the Communication Adapter Module is compatible with both Local and Remote I/O PLC Processors.

The normal operating sequence of the station Processor is not changed by the Communication Adapter Module. That is, the Processor carries out its scan of input and output modules and execution of the user program transparent to Communication Adapter Module operation.

The interaction between the Communication Adapter Module and its station Processor is in the control of memory locations. The station Communication Adapter Module can read data from and write data into the Processor memory, based on user-programmed commands.

**TABLE 2-1 — Operating Specifications — Communication Adapter Module (Cat. No. 1774-KA)**

|                                                                                     |
|-------------------------------------------------------------------------------------|
| <b>Function</b>                                                                     |
| Interface a PLC Programmable Controller to the Data Highway                         |
| <b>Location</b>                                                                     |
| Bulletin 1774 Processor Chassis<br>(Slot No. 0, 1, 2, or 3)                         |
| <b>Communication Channels</b>                                                       |
| Channel A to Data Highway<br>Channel B to redundant Data Highway (optional)         |
| <b>Communication Rates</b>                                                          |
| To Data Highway: 57.6k baud (recommended)<br>To PLC Processor: direct memory access |
| <b>Power Supply Requirement</b>                                                     |
| +5V DC at 2A (max.)                                                                 |
| <b>Ambient Temperature Rating</b>                                                   |
| 0° to 60°C (operational)<br>-40° to 85°C (storage)                                  |
| <b>Humidity Rating</b>                                                              |
| 5% to 95% (without condensation)                                                    |

The commands which originate from any station Communication Adapter Module can control only Data Table memory areas of the Processor. Commands that originate from a computer connected through a Communication Controller Module (Cat. No. 1771-KC, -KD) can control user program memory areas in addition to Data Table locations.

Note that the Processor continues to execute the user program and control output devices whether or not the station Communication Adapter Module is in operation. Thus, disconnection of the Data Highway Cable or faulted operation of the Communication Adapter Module does not cause shutdown of the station Processor.

A PLC Processor may have more than one Communication Adapter Module. This would permit one Processor to communicate with 2 separate Data Highways. Or, this might permit redundancy in an application where 2 Communication Adapter Modules communicate with the same Processor.

Where multiple Communication Adapter Modules are used in a single Processor, the following are required:

- A unique Station No. for each Module
- A unique and separate set of Communication Zone rungs for each Module (Refer to Section 5)
- A unique word in the 9-word Status Area at the end of Processor memory for each Module (Refer to paragraph 2.2.1)

### 2.2.1 Status Area Control

As an optional Processor Module, the Communication Adapter Module (Cat. No. 1774-KA) controls and uses parts of a reserved 9-word Status Area at the end of PLC memory. It shares control of this Status Area with other optional Processor Modules of current Cat. No. and Series level. These current optional Processor Modules are:

- Computer Interface Module (Cat. No. 1774-CI2, Series C)
- Program Panel Interface Module (Cat. No. 1774-TB2, Series B)
- Data Handling Module (Cat. No. 1774-DH2, Series C or Cat. No. 1774-DH3)
- On-Line Programming Module (Cat. No. 1774-TL2, Series C)

In the description which follows, the optional Processor Modules listed here are referred to as current optional Processor Modules. Note that the **full Cat. No.** and **Series level** of each of these Modules is important. Modules of earlier Series and those having Cat. Nos. not suffixed by "-2" or "-3" exactly as listed here are not fully compatible with respect to Status Area control.

The primary function of the Status Area is to control the access of optional Processor Modules to that part of memory which contains the following:

- User program
- Messages stored by the Data Handling Module

- Data Files stored by the Data Handling Module

This area of memory is beyond the Data Table. (Refer to the memory maps of Section 10.)

The Status Area indicates whether or not an optional Processor Module is reading from or writing into this part of memory beyond the Data Table. Because all current optional Processor Modules check the Status Area before accessing user memory, this guards against concurrent write and read operations affecting the user program, messages and data files. In general, when only the **current** optional Processor modules are used, in a standard configuration, Status Area control is automatic; no user action is required to implement this control function.

However, there are certain cases where some user action may be required for Status Area control. These cases are as follows:

- Case 1 — More than one Communication Adapter Module is used in a single Processor Chassis.
- Case 2 — The Processor Chassis contains a Module of earlier than current Cat. No. or Series level, as listed in this paragraph.

The following paragraphs outline Status Area control considerations for each of these cases. Again, should neither of these cases apply to an individual application, no switch settings or other user action need be taken for Status Area control.

#### CASE 1—MORE THAN ONE MODULE USED

Should multiple Communication Adapter Modules be used in a single Processor Chassis, each of these Modules must be assigned the control of a unique word in the Status Area. This word, which indicates when its associated Module is accessing memory, is termed the Communication Word. In order to designate a different Communication Word for control by the additional Communication Adapter Module, the user must determine which unused Communication Word is available. Then, the user must make an appropriate switch setting on the Module to select this word.

In the 9-word Status Area, there are 4 Communication Words. Because the addresses of these words are transparent to the user, these words can be designated simply as Communication Words No. 1 through No. 4. Note that the PLC Processor Chassis has 4 slots for optional Processor Modules. With this arrangement, each optional Module in the Chassis is thus intended to control a unique Communication Word.

As shipped, each current optional Processor Module automatically controls a designated Communication Word. Table 2-2 lists this Word for each optional Processor Module. (Certain Modules are grouped together to use the same word — for example, the Data Handling and Protected Logic Modules both use Word No. 2. This arrangement is used because these Modules are seldom used together in the same Processor Chassis.)

**TABLE 2-2 — Status Area Communication Word Assignments of Optional Modules as Shipped**

| MODULE TYPE                                                   | CAT. NO.                        | STATUS AREA COMMUNICATION WORD |
|---------------------------------------------------------------|---------------------------------|--------------------------------|
| Communication Adapter Module                                  | 1774-KA                         | No. 1                          |
| Data Handling Module/Protected Logic Module                   | 1774-DH2<br>or -DH3<br>1774-DL2 | No. 2                          |
| Computer Interface Module                                     | 1774-CI2                        | No. 3                          |
| Program Panel Interface Module/<br>On-Line Programming Module | 1774-TB2<br>1774-TL2            | No. 4                          |

If 2 Communication Adapter Modules were used in the same Processor without a switch alteration on one of the Modules, both Modules would attempt to control Communication Word No. 1. This would defeat the purpose of the Communication Word in controlling memory access of these Modules. Therefore, a switch setting is made on one of the Modules to give it control of a different Communication Word. To

choose this Word, examine Table 2-2 and determine which Communication Word is not being used by any other optional Module in the Processor Chassis. Then, set Switches No. 1 and 2 of the Status Area Switch Assembly to the proper setting for this unused word, as described in paragraph 3.1.5.

Figure 2-4 gives an example of a Chassis containing two Communication Adapter Modules, along with the following:

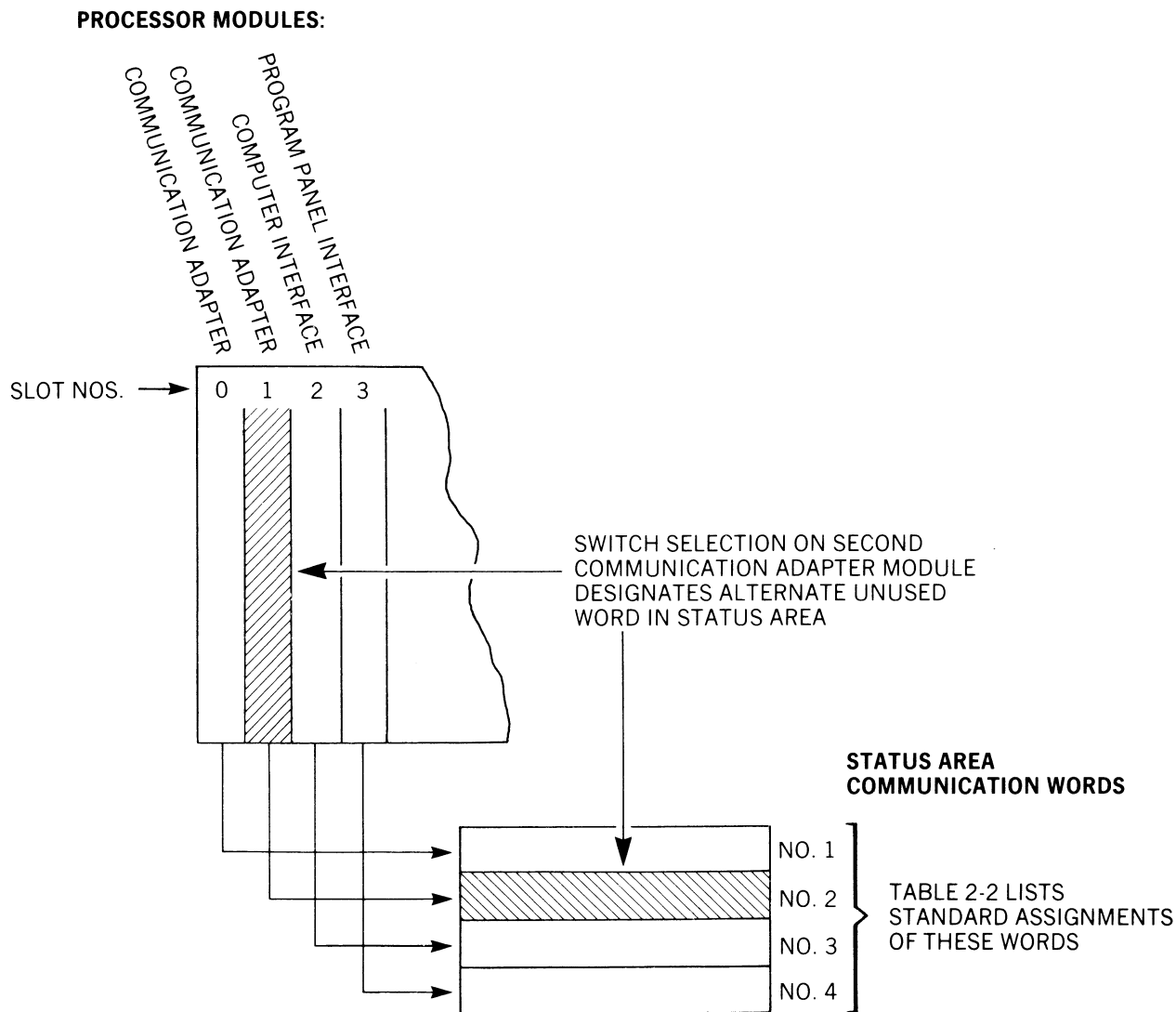
- Program Panel Interface Module
- Computer Interface Module

In this example, only one unused Communication Word exists in the Status Area: Word No. 2.

Thus, this word can be used for one of the Communication Adapter Modules. (The other Communication Adapter Module, of course, would continue to control Word No. 1.) In this example then, each Module would control a unique Communication Word in the Status Area of memory.

### CASE 2—USED WITH NON-CURRENT OPTIONAL MODULE

A PLC Processor may contain optional Modules of earlier Series level or Cat. No. than those listed as “current.” In some of these cases, it may be necessary to disable Module Status Area control. There are 2 instances



**FIGURE 2-4 — PLC Processor Containing 2 Communication Adapter Modules (Example)**

where it is necessary to consider disabling the Status Area control function:

- When using a Data Handling Module with Cat. No. 1774-DH or Cat. No. 1774-DH2, Series A.
- When the user program fills or very nearly fills memory.

Whenever a Data Handling Module of earlier types is used in the same Processor Chassis as a Communication Adapter Module, Status Area control must be disabled. This is because these earlier Data Handling Modules do not set aside a special 9-word Status Area for use by optional Modules. Instead, Data Handling Modules of these types use the end of memory for a different purpose. Thus, the Status Area function of the Communication Adapter Module could not be used and must be disabled. The Status Area Inhibit Switch is turned ON in these cases. (This switch setting is described in paragraph 3.1.5.)

For all optional Processor Modules other than Data Handling Modules, Status Area control may be disabled at the programmer's option.

Unlike the current optional Processor Modules, the earlier versions of these Modules do not automatically reserve the last 9 words of user memory for any Status Area function. Thus, when using a Communication Adapter Module with any of these earlier Modules, the programmer must carefully consider his use of memory. If user program instructions extend into the last 9 words of memory, the Status Area control feature cannot operate as intended. The Communication Adapter Module would attempt to write over any programmed instructions in this area of memory. If this were to happen, a Memory End Error indicator on the Module would illuminate and Controller outputs would be disabled.

To guard against this situation, one of the following may be possible:

- Shorten the user program, perhaps by eliminating redundant logic
- Add an additional Memory Module (Cat. No. 1774-MA) if space permits

Even if the user program can be shortened or another Memory Module added, however, there is no certainty that subsequent programming would not use the last 9 words of memory. Therefore, it is normally recommended that Status Area control be disabled in any case where these last 9 words of user memory might be used for storage of program instructions. To disable Status Area control, set Switch No. 3 of the Status Area Switch Assembly ON. (Refer to paragraph 3.1.5.)

### **2.2.2 Word 000**

Reserve Output Image Table word 000 when using the Communication Adapter Module. This means that instructions in the user program must not address word 000 or any of its bits. This also means that word 000 must not be addressed by a Write or Bit Write command from any other station.

## **2.3 DATA HIGHWAY CABLE**

The Data Highway Cable has 2 parts: a trunkline and droplines. The central transmission cable which links all stations together is termed the trunkline. At each station, a dropline connects a Communication Adapter or Communication Controller Module to the trunkline. Both trunkline and dropline segments of the Data Highway Cable are assembled by the user to fit his configuration of Data Highway stations.

The user constructs this cable using the following hardware:

- Twinaxial Cable (Cat. No. 1770-CD)
- Connector Kit (Cat. No. 1770-XG)
- Terminator Set (Cat. No. 1770-XF)

This hardware is not provided with the Module, but must be ordered separately.

The Twinaxial Cable consists of a shielded twisted pair of conductors. Belden No. 9463 cable can be used. The Connector Kit provides junction connection hardware to connect the dropline and trunkline segments of this cable. This Kit also includes the plug connector for the Communication Adapter Module socket. The Terminator Set provides a pair of terminating resistors for the extreme ends of the trunkline.

Assembly and installation of the Data Highway Cable is outlined in Publication 1770-810.

## **2.4 OTHER OPTIONAL EQUIPMENT**

In addition to the components shown in Figure 2-1, various user-selected equipment can be installed at or near the Data Highway station. The chief purpose of these additional components is to provide diagnostic or monitoring information. Such devices as alarms, displays

and indicators may be controlled from output modules of the controller to provide operating or fault information to plant personnel.

Minimally, a single indicator must be installed to alert user personnel to a REMOTE or LOCAL FAULT condition which prevents normal message transfer. The significance of REMOTE/LOCAL FAULT bits and programming to monitor these bits are described in Section 7.

## Section 3 MODULE INSTALLATION

### 3.0 GENERAL

This Section outlines the procedures for preparation, installation, and connection of the Communication Adapter Module. Before performing these procedures, the user should check over the component compatibility and station set-up recommendations of Section 2.

### 3.1 SWITCH SETTINGS

The Communication Adapter Module has the following switch assemblies:

- Write Options Switch Assembly
- Data Highway Baud Rate Switches
- Output State Switch
- Station No. Switch Assembly
- Status Area Switch Assembly

Refer to Figure 3-1. These switches are located on the printed circuit board of the Module. They are accessible through cutouts in the Module cover. When the Module is shipped, most of these switches are set to the OFF position. (Only the Data Highway Baud Rate Switches are set in the ON position; this selects the recommended baud rate for Data Highway communication.) With this arrangement, the Module Station No. is set at 000 and most Module command functions are disabled.

The switches at each station Communication Adapter Module must be set as the programmer specifies. For troubleshooting purposes, it is strongly recommended that the programmer document the required switch settings for each Communication Adapter Module. Form No. 5031 (in Section 10) can be used to record

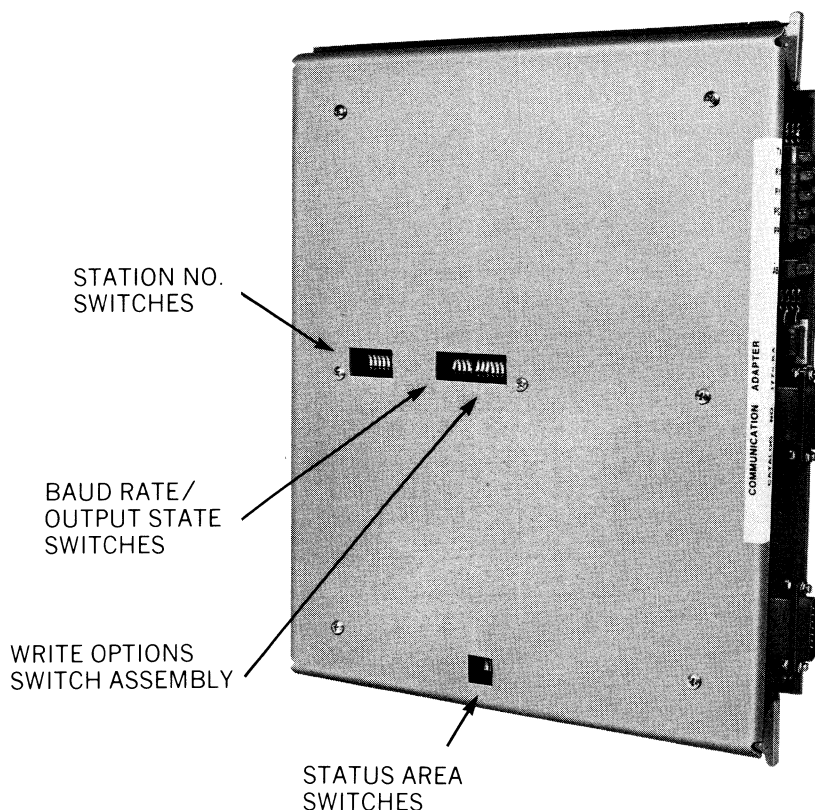


FIGURE 3-1 — Module Switches



switch settings for the Module at each station. Should replacement of the Module be required at some later time, switches on the replacement Module can be quickly set, using this Form as a reference.

Prepare to set these Module switches by laying the Module flat, with its front edge facing left. This orients the switches on the Module for the procedures and illustrations that follow. Use the tip of a ball-point pen or other pointed instrument to set these switches.

### 3.1.1 Write Options Switch Assembly

The Write Options Switch Assembly is an 8-switch assembly in the center of the Module. Refer to Figure 3-2. With the Module oriented as described in Paragraph 3.1, this is the left-

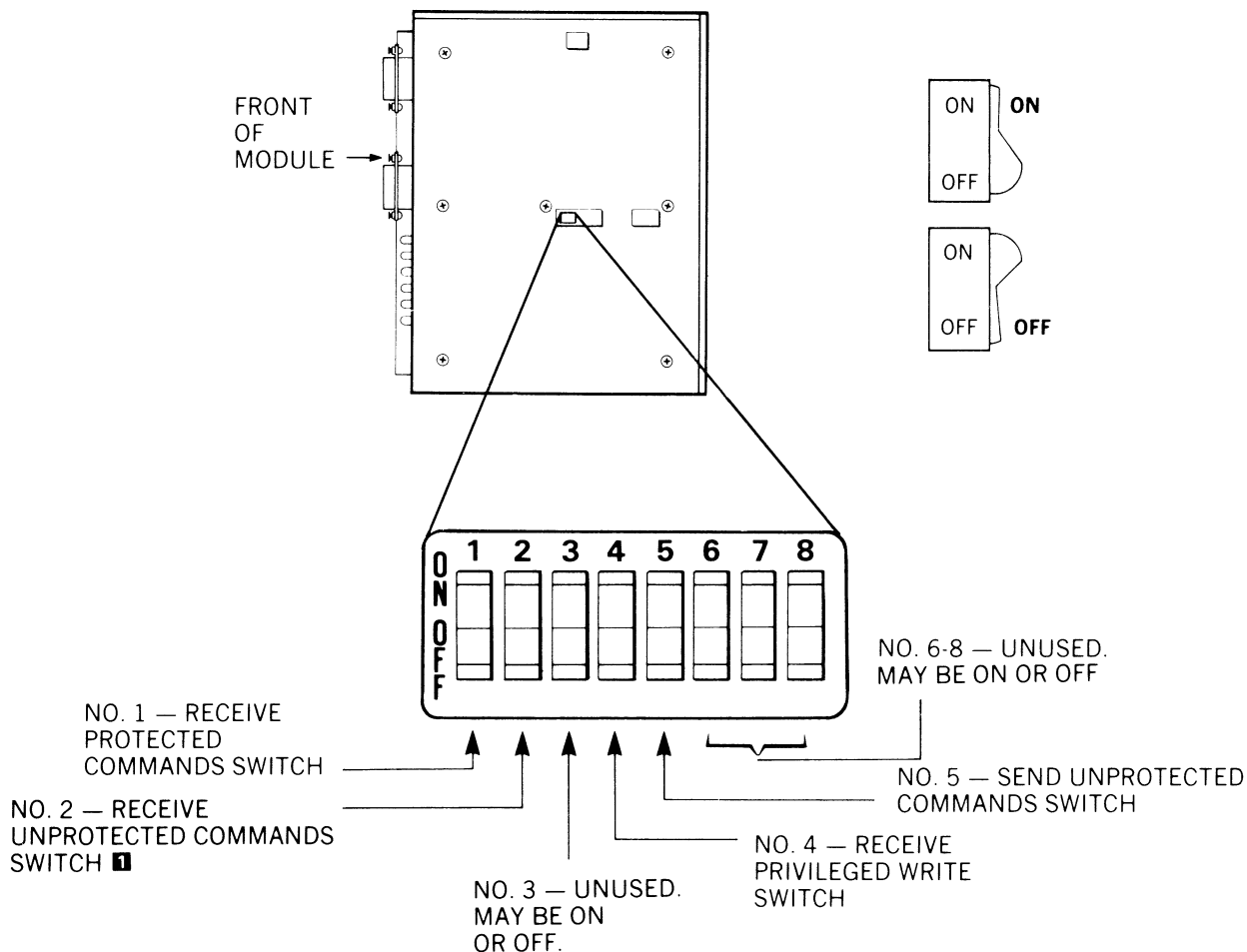
most switch assembly along the center of the Module. This switch assembly allows the user to enable or disable execution of various types of commands.

Switches No. 1,2,4, and 5 of this assembly must be set during installation of the Module. Switches No. 3,6,7, and 8 are not used and may have any setting.

The following paragraphs describe the setting of Switches No. 1,2,4, and 5.

#### RECEIVE PROTECTED COMMANDS SWITCH (SWITCH NO. 1)

Switch No. 1 of the Write Options Switch Assembly determines whether or not the Module is enabled to receive and execute Protected Write and Bit Write commands from other stations. Set this switch as follows:



1 Does not disable execution of received Unprotected Read commands.

**FIGURE 3-2 — Write Options Switch Assembly**

- ON — Enables received Protected commands to be executed.
- OFF — Disables the Module from executing received Protected commands

Note that both an ON setting of this switch and a Memory Access rung are required to allow execution of received Protected commands. (Memory Access rungs are described in Section 5.)

This switch does not prevent the Module from receiving and executing Unprotected commands from another station. (A separate switch, described subsequently, enables or disables execution of received Unprotected Write and Bit Write commands.)

#### RECEIVE UNPROTECTED COMMANDS SWITCH (SWITCH NO. 2)

Switch No. 2 of the Write Options Switch Assembly determines whether or not the Module can receive and execute Unprotected Write and Bit Write commands from other stations. Set this switch as follows:

- ON — Enables received Unprotected Write and Bit Write commands to be executed.
- OFF — Disables the Module from executing received Unprotected Write and Bit Write commands

Note that this switch does not disable Unprotected Read commands from being received and executed by the Module. (Unprotected Read commands cannot be disabled by a Module switch setting.)

#### RECEIVE PRIVILEGED WRITE SWITCH (SWITCH NO. 4)

Switch No. 4 of the Write Options Switch Assembly determines whether or not the Module can execute received Privileged Write commands. These commands can be issued only from a computer connected through a Communication Controller Module (Cat. No. 1771-KC, -KD). These commands give the computer the capability to alter the User Program memory of the station Processor. Set this switch as follows:

- ON — Enables the Module to execute received Privileged Write commands

- OFF — Disables the Module from executing received Privileged Write commands

#### SEND UNPROTECTED COMMANDS SWITCH (SWITCH NO. 5)

Switch No. 5 of the Write Options Switch Assembly determines whether or not the Module can send Unprotected Write or Bit Write commands to another station. Set this switch as follows:

- ON — Enables the Module to send Unprotected Write and Bit Write commands
- OFF — Disables the Module from sending Unprotected Write and Bit Write commands

This switch does not prevent Unprotected Read commands from being sent by a Communication Adapter Module. (Unprotected Read commands cannot be disabled by a Module switch setting.)

### **3.1.2 Data Highway Baud Rate Switches**

Refer to Figure 3-3. To the right of the Write Options Switch Assembly is a switch assembly containing 4 rocker switches. Switches No. 1 and 2 of this assembly are the Data Highway Baud Rate Switches. These switches must be set for the communication rate being used on the Data Highway communication link.

The Module is shipped with these switches set for 57.6k baud. Both switches are set ON for this communication rate. This baud rate is the intended Data Highway communication rate, current with the date of this Publication.

**CAUTION:** Do not set these switches for any other baud rate unless specifically instructed to do so by Application Engineering, Programmable Controller Systems Division, Allen-Bradley Co. Incorrect setting of these switches may cause faulted data transmission on the Data Highway communication link.

### **3.1.3 Output State Switch**

Refer to Figure 3-3. The Output State Switch is Switch No. 3 in the same switch assembly which includes the Data Highway Baud Rate Switches. The setting of the Output State

Switch determines the status of Controller output devices during the time the Communication Adapter Module is executing received Privileged Write commands. These commands are used for program downloading from a computer connected through a Communication Controller Module (Cat. No. 1771-KC, -KD).

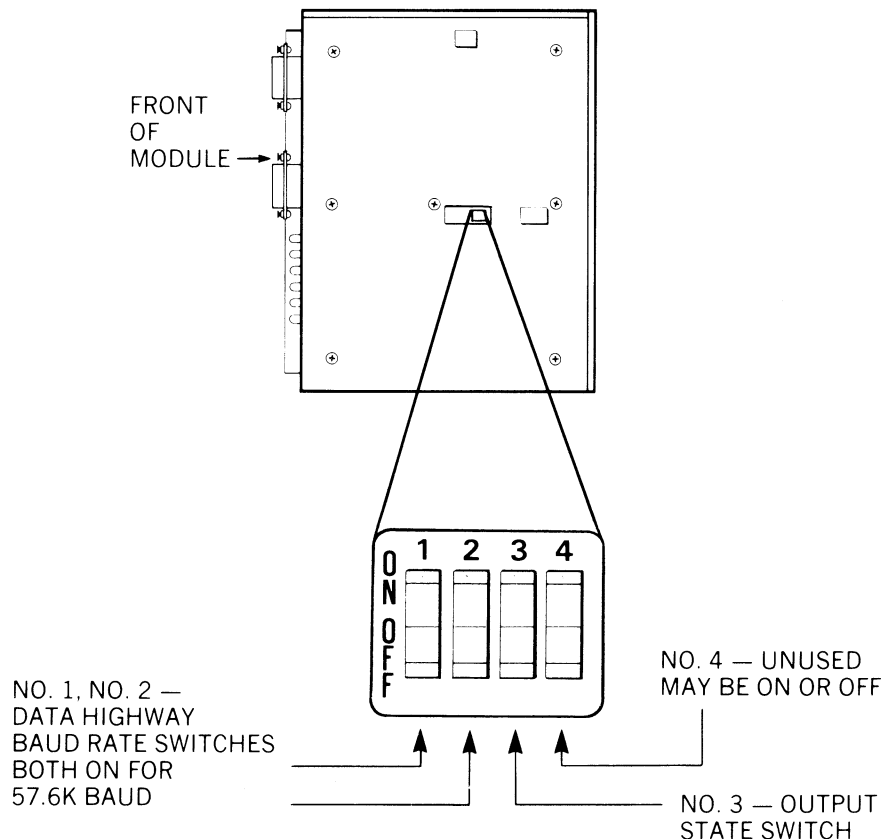
Set this switch as follows:

- ON — Controller output devices are held in their last state, whether ON or OFF, during execution of received Privileged Write commands to the user program area of memory.
- OFF — Controller output devices are turned OFF during execution of received Privileged Write commands to the user program area of memory.

Output status during the execution of Privileged Write and Bit Write commands is based on the ON/OFF setting of this switch.

Once execution of these commands has been completed, however, control of the outputs does not automatically return to the station PLC Processor. In order to return output control to the Processor, the computer must issue an Output Control command. This type of command, which can be sent from a computer connected through a Communication Controller Module, will normally follow a sequence of Privileged Write commands. (More information on program downloading can be found in the User's Manual, Communication Controller Module, Publication 1771-802.)

If, for some reason, it is not desirable to program and use the Output Control command to return output control to the Processor, an alternate method to restart the Controller after downloading is available. To do this, turn the Mode Select Switch on the Processor to PROGRAM LOAD position, then back to RUN-MONITOR or RUN/PROGRAM LOAD position. (Note that turning the Mode Select Switch to PROGRAM LOAD will disable all Controller outputs.)



**FIGURE 3-3 — Baud Rate/Output State Switches**

Note that the Output State Switch controls the state of Controller outputs only during program downloading from another station on the Data Highway. Should a program be loaded by means of a Program Panel connected to the Program Panel Interface Module, controller outputs would be disabled, since the Controller must be placed in the PROGRAM LOAD mode for this operation.

### 3.1.4 Station No. Switch Assembly

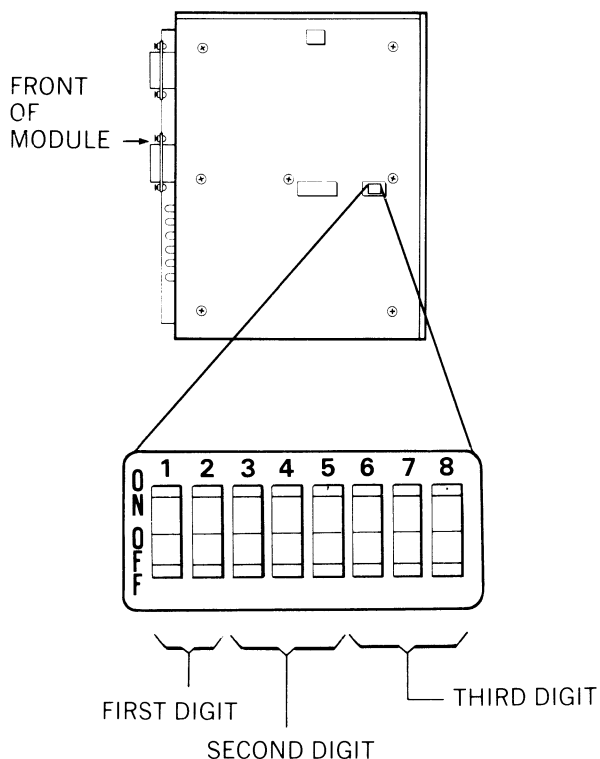
A unique Station No. must be designated for each Communication Adapter Module in a Data Highway installation. This number, designated by the programmer, is switch-selected on the Station No. Switch Assembly of the Module. The Station No. Switch Assembly is a set of 8 rocker switches on the Module circuit board. When the Module is oriented as described in Paragraph 3.1, this switch assembly is to the right of the 8- and 4-switch assemblies described in the previous paragraphs. (Refer to Figure 3-1.)

The switches of this assembly determine the Station No. of the Module. The Station No. is a 3-digit octal number from 010<sub>8</sub>-077<sub>8</sub> or 110<sub>8</sub>-

117<sub>8</sub>. The switches in this assembly, therefore, are grouped to represent this 3-digit number in binary-coded octal format: Switches No. 6-8 are set to represent the least significant digit, Switches No. 3-5 are set to represent the middle digit, and Switches No. 1 and 2 are set to represent the most significant digit of the Station No. This arrangement is illustrated in Figure 3-4.

In this binary-coded octal numbering arrangement, each switch has an associated binary value: 1, 2, or 4 if set ON, 0 if set OFF. The value of each digit, then, is the sum of the binary values of its corresponding group of switches. In Figure 3-4, the settings of these switches for each digit of the Station No. are listed. Table 3-1 gives an example for the setting of this switch assembly.

Note that the switches allow a range of Station Nos. from 000<sub>8</sub> to 377<sub>8</sub> (256 possible numbers). However, there are practical reasons for using the range 010<sub>8</sub>-077<sub>8</sub> and 110<sub>8</sub>-117<sub>8</sub>. These Station Nos. are addressable from any station using any of the available Program Panels or the Industrial Terminal. Because a maximum number of 64 stations is possible,



| SWITCH SETTING |       | DIGIT |
|----------------|-------|-------|
| NO. 1          | NO. 2 |       |
| OFF            | OFF   | 0     |
| OFF            | ON    | 1     |
| ON             | OFF   | 2     |
| ON             | ON    | 3     |

A. FIRST DIGIT

| SWITCH SETTING |         |         | DIGIT |
|----------------|---------|---------|-------|
| No. 3,6        | No. 4,7 | No. 5,8 |       |
| OFF            | OFF     | OFF     | 0     |
| OFF            | OFF     | ON      | 1     |
| OFF            | ON      | OFF     | 2     |
| OFF            | ON      | ON      | 3     |
| ON             | OFF     | OFF     | 4     |
| ON             | OFF     | ON      | 5     |
| ON             | ON      | OFF     | 6     |
| ON             | ON      | ON      | 7     |

B. SECOND AND THIRD DIGITS

FIGURE 3-4 — Station No. Switch Assembly

**TABLE 3-1 — Switch-Setting Example: Station No. 037**

| STATION NO.<br>DIGITS | 0   |     | 3   |    |    | 7  |    |    |
|-----------------------|-----|-----|-----|----|----|----|----|----|
| SWITCH NO.            | 1   | 2   | 3   | 4  | 5  | 6  | 7  | 8  |
| SWITCH<br>SETTING     | OFF | OFF | OFF | ON | ON | ON | ON | ON |

use only Station Nos. in the range 010<sub>8</sub>-077<sub>8</sub> and 110<sub>8</sub>-117<sub>8</sub>.

Note: Where multiple Communication Adapter Modules are used in a single Processor Chassis, a different Station No. must be designated for each Communication Adapter Module.

Do not use 377 as Station No. for any Data Highway station.

### 3.1.5 Status Area Switch Assembly

The Status Area Switch Assembly is a set of 4 rocker switches located near the bottom of the Module. (Refer to Figure 3-1.) In most cases, the settings of these switches need not be altered from their original settings as shipped. However, under some circumstances, the switches in this switch assembly may require user setting for Status Area word control.

Paragraph 2.2.1 describes the use and function of the Status Area and gives 2 cases where some alteration of switch settings in this assembly may be necessary. For Case 1 situations, Switches No. 1 and 2 may require an alternate setting. For Case 2 situations, Switch No. 3 may be required to be set ON.

Switch No. 4 of this assembly is unused and may have any setting.

Figure 3-5 summarizes the significance of these switches.

#### COMMUNICATION WORD SELECT SWITCHES (CASE 1)

Switches No. 1 and 2 of this assembly are the Communication Word Select Switches. When the Module is shipped, these switches are both OFF. As Figure 3-5 shows, the Module automatically controls Communication Word No. 1 with this setting.

An alternate setting of this switch is necessary if more than one Communication Adapter Module is used in a Processor. In this case, one of these Modules must use some word other than Communication Word No. 1 and other than a word controlled by some other optional Processor Module. Table 2-1 lists the Communication Word which is automatically controlled by each type of current optional Processor Module. Based on this Table, select a Communication Word not used and switch-select this word for control by one of the Communication Adapter Modules. Figure 3-5 gives Module switch settings for each of the 4 possible Communication Words.

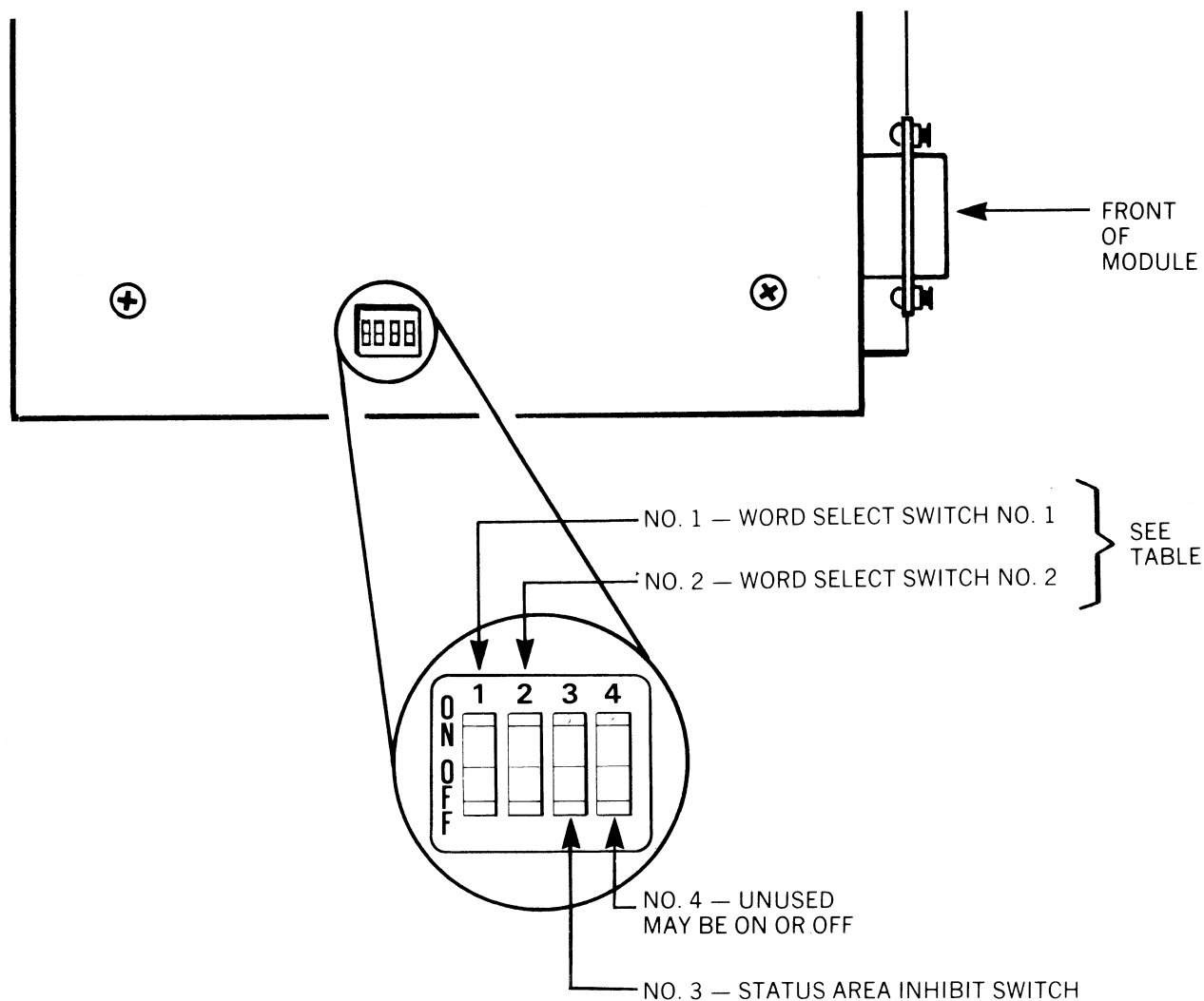
A brief example of Communication Word selection is given in paragraph 2.2.1.

#### STATUS AREA INHIBIT SWITCH (CASE 2)

Switch No. 3 of this assembly is used to inhibit Status Area control by the Module. When the Module is shipped, this switch is set OFF. With this setting, the Module automatically formats the 9-word Status Area at the end of Processor memory and controls Communication Word No. 1, as determined by Switches No. 1 and 2 of this assembly.

There are situations, however, where Status Area control may conflict with other optional Processor Modules of earlier Cat. No. and Series. Paragraph 2.2.1 described these as Case 2 situations. In these cases, it may be necessary to set this switch ON. This setting inhibits the Status Area control of the Module.

This switch must always be set ON when using a Data Handling Module of either Cat. No. 1774-DH or Cat. No. 1774-DH2, Series A.



| Word Select Switch No. 1                                                                                    | Word Select Switch No. 2 | Communication Word in Nine-word Status Area |
|-------------------------------------------------------------------------------------------------------------|--------------------------|---------------------------------------------|
| OFF*                                                                                                        | OFF*                     | No. 1                                       |
| OFF                                                                                                         | ON                       | No. 2                                       |
| ON                                                                                                          | OFF                      | No. 3                                       |
| ON                                                                                                          | ON                       | No. 4                                       |
| * The Communication Adapter Module (Cat. No. 1774-KA) is shipped with the switches set to this combination. |                          |                                             |

FIGURE 3-5 — Status Area Switch Settings

### 3.2 INSTALLATION IN THE PROCESSOR CHASSIS

Once all Module switches have been set, follow these procedures:

**Step 1** — Turn Processor power OFF.

**CAUTION:** Always turn Processor power OFF before insertion or removal of a Processor Module. Failure to take this precaution can result in damage to Module logic circuitry.

On later Series Processors an Interlock Bar or Switch is provided inside the Processor to turn power OFF.

**Step 2** — Insert the Communication Adapter Module into its designated slot in the Processor Chassis.

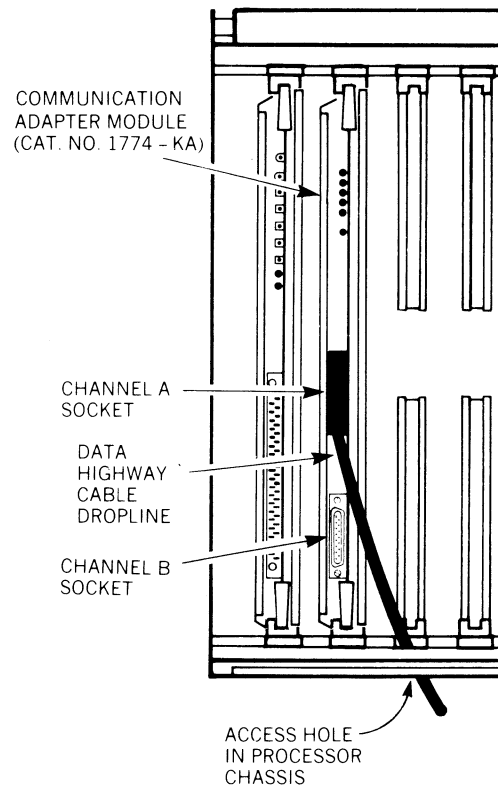
The Module can be seated in any of the first four slots from the left. (These slots are numbered 0-3.)

Press the Module gently but firmly into the backplane connectors of the Processor Chassis.

**Step 3** — Connect the 15-pin connector from the Data Highway Cable dropline to the Module

socket labeled "A." (Refer to Figure 3-6.)

Start-up procedures are described in Section 9.



**FIGURE 3-6 — Connection to Data Highway Cable**

## Section 4 COMMANDS

### 4.0 GENERAL

The primary function of the Communication Adapter Module is the transfer of data to and from its station Processor. The Communication Adapter Module is instructed to transfer specific units of data by user-programmed commands. The Communication Adapter Module has the following set of commands:

- Protected Write
- Protected Bit Write
- Unprotected Write
- Unprotected Bit Write
- Unprotected Read

These commands are of 3 general types: Write, Bit Write, and Read. (Refer to Figure 4-1.) The Write and Read commands transfer word data between the Data Table of the local station

Processor and the Data Table of a remote station Processor. The Bit Write command controls ON/OFF status of one or more memory bits at a remote station Processor.

This Section describes the function of these commands and their access to Data Table locations at station Processors. Subsequent Sections then cover the following topics:

- Command programming (Section 5)
- Command status bits (Section 6)
- Command initiation and execution monitoring (Section 7)

#### 4.0.1 Terminology: Remote/Local Station

In this and subsequent Sections, the terms "remote station" or "local station" are used. The local station is the point of reference; when describing the commands, for instance,

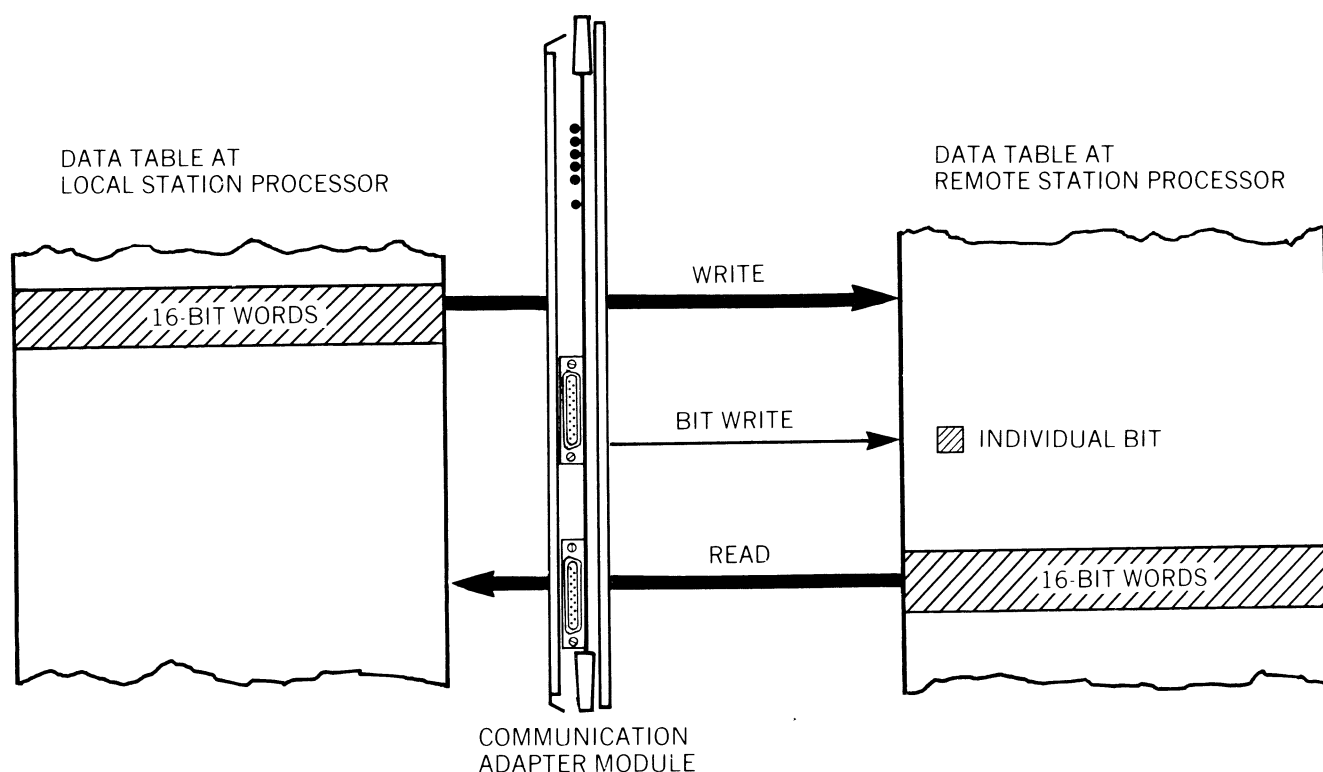


FIGURE 4-1 — Module Command Functions



the local station is that station sending the command. The remote station refers, then, to any station which receives a command from the local station.

The use of this terminology is illustrated in Figure 4-1.

#### 4.1 PROTECTED/UNPROTECTED

Each Communication Adapter Module command has a prefix, either "Protected" or "Unprotected." This prefix denotes memory access of the command. The distinction between these command types is as follows:

- **Protected** — The memory access of Protected commands is controlled by the receiving station. These commands may access only Data Table areas specified in the program at the receiving station Processor. A Memory Access rung, programmed at the receiving station Processor, defines which memory areas are accessible to a Protected Write or Protected Bit Write command. (These rungs are described in Section 5.)

Should a Protected command address a memory area not defined by a Memory Access rung at the receiving station, that command is not executed.

- **Unprotected** — The memory access of Unprotected commands is not restricted by the program at the receiving station.

These commands can access any addressable Data Table word without the need for a Memory Access rung at the receiving station.

Note that the primary distinction between these commands is program restriction of memory access. Switch selections can also be made on the Module for write protection, to enable/disable execution of many of these commands. (Switch selections are given in Section 3.)

Figure 4-2 summarizes the distinction between Protected and Unprotected commands.

NOTE: For most Write and Bit Write operations between station Processors, **Protected** commands should be used. Because memory access must be allowed by the program at the receiving station Processor, Protected commands allow programmed write protection, which gives the programmer an added degree of control over command execution. Commands of the Unprotected type provide the same functions in transferring data, but without this write protection at the receiving station.

#### 4.2 WRITE COMMANDS

A Write command transfers word data from the local station Processor to a remote station. A single Write command can send from 1 to 121 consecutive Data Table words.

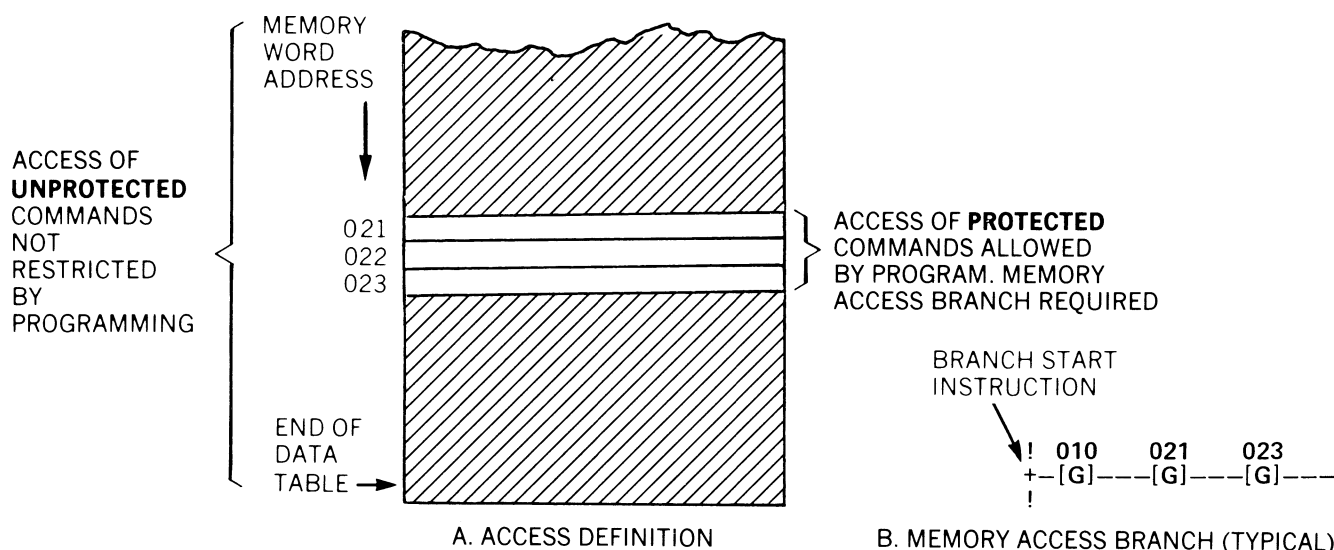


FIGURE 4-2 — Protected/Unprotected Command Distinction

There are 2 types of Write commands which can be sent from a station Communication Adapter Module:

- Protected Write
- Unprotected Write

The distinction between these types of commands is their memory access. Protected Write commands are not executed by the receiving station unless a Memory Access rung is programmed at that station. Because this allows added control over data transfer, use of Protected commands is recommended.

A Write command can control Data Table words at any station Processor. However, certain Data Table areas at each type of Processor have a special function and should not be controlled by Write commands. (Data Table control is the subject of Paragraphs 4.5 and 4.6)

On each Communication Adapter Module, the sending and receiving of Write messages can be enabled or disabled by switch settings. (Refer to Section 3.)

### 4.3 BIT WRITE COMMANDS

Bit Write commands control the ON/OFF status of bits in a remote station Data Table. Unlike Read or Write commands, the Bit Write commands do not transfer Data Table memory data. Instead, the programmed Command rung itself specifies which bits are to be set ON or OFF when the command is executed. (Refer to Section 5.)

There are 2 types of Bit Write commands which can be sent from a Communication Adapter Module:

- Protected Bit Write
- Unprotected Bit Write

The distinction between these types of commands is their memory access. Protected Bit Write commands are not executed by the receiving station unless a Memory Access rung defining the appropriate memory area is programmed at that station. Because this write protection feature allows added control over command execution, use of Protected commands is recommended.

A Bit Write command can control Data Table areas at any station Processor. However, certain Data Table words at each type of Processor have a special function and should not be controlled by Bit Write commands. (Data Table control is the subject of Paragraphs 4.5 and 4.6.)

On each Communication Adapter Module, the sending and receiving of Bit Write messages can be enabled or disabled by a switch setting. (Refer to Section 3.)

#### 4.3.1 Bit Write Access

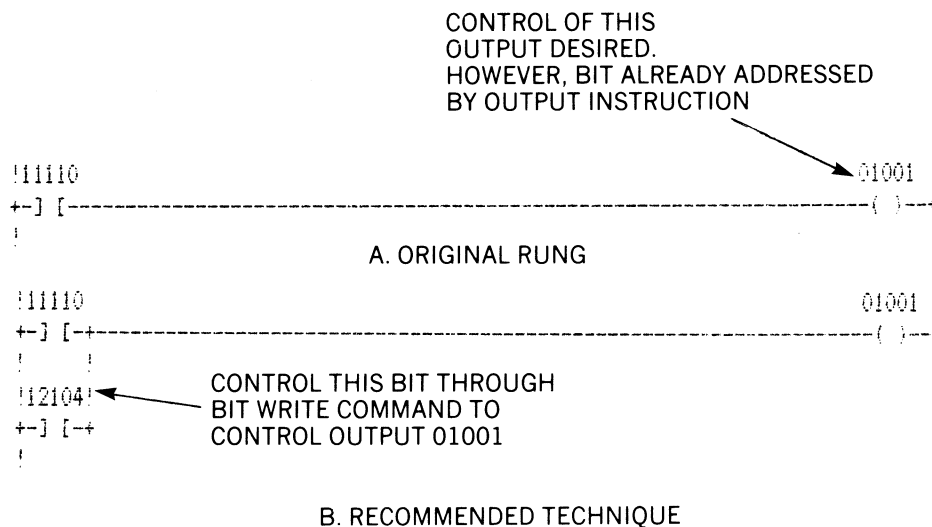
The Bit Write command can be used to control any accessible Data Table bit. However, this command must not be used to control the following:

- Any bit whose status is controlled by a programmed output instruction
- In any of the PLC-2/20 or PLC-2 Processors or Mini-Processor Module: any bit in a byte which also contains program-controlled bits.

This first restriction simply states that no bit should be directly controlled, that is, addressed, by both an output instruction at its local station Processor and a Bit Write command from some remote station Processor. This rule applies to both Bulletin 1774 PLC and Bulletin 1772 PLC-2 Processors.

Bit Write commands are generally used to set **storage** bits in a station Processor Data Table. These storage bits may then be examined in the user program as conditions to energize an output bit. This indirect programming technique allows control using Bit Write commands, but helps to prevent the confusion that can result if an individual bit is controlled from both an OUTPUT ENERGIZE instruction and a Bit Write command.

Figure 4-3 gives an example of an indirect programming technique used to control bit 01001, which is addressed by an output instruction, with a Bit Write command. Here storage bit 12104 is controlled by the Bit Write command. This bit is then examined by the program to control the status of bit 01001. Note that the output bit, 01001, cannot be



**FIGURE 4-3 — Bit Control Use (Example)**

directly addressed by the Bit Write command. However, by controlling the storage bit and examining that bit in the program, the same effect is achieved.

The second restriction listed here applies to all Bulletin 1772 PLC-2 Processors. For these Processors, when the station Communication Adapter Module receives a Bit Write command, it manipulates the 8-bit **byte** of the 16-bit memory word in which the addressed bit is located. (This may be the low byte, containing bits 00-07, or the high byte, containing bits 10-17.) Should program instructions control other bits within this same byte, there is a slight possibility that the Communication Adapter Module may write over programmed status for these program-controlled bits. This would occur only if the program caused a bit to be altered during the time the Communication Adapter Module was executing a received Bit Write command.

Therefore, when using the Bit Write command, address only bits within a byte which is set aside exclusively for control by these commands.

Note that this byte restriction for Bit Write commands does not apply to PLC Processors. The Communication Adapter Module (Cat. No.

1774-KA) has direct memory access to PLC Processor memory.

#### 4.4 READ COMMAND

The Unprotected Read command transfers word data from a remote station Processor to the local station Data Table. A single Unprotected Read command can access from 1 to 122 consecutive Data Table words.

The Unprotected Read command is not restricted by user programming. This command can read Data Table words from any remote station Processor, regardless of either Memory Access rung programming or Module switch settings.

Because this command controls Data Table words at its local station Processor, the rules for Data Table control apply when using this command. (Data Table control is the subject of Paragraphs 4.5 and 4.6.)

#### 4.5 ACCESSIBLE DATA TABLE LOCATIONS — PLC PROCESSORS

When it executes a Read, Write, or Bit Write command, the Communication Adapter Module controls Data Table locations at a station Processor. When addressing a command to a Bulletin 1774 PLC Processor, note that there

are certain Data Table areas with a special function. These Data Table areas are not to be used for control by Communication Adapter Module commands:

- Any Input Image Table word which has a corresponding input module in a Bulletin 1778 or 1771 I/O Rack
- Word 377
- Word 000

Access to other Data Table words should be determined only after a careful review of memory areas used by the program. Note that when the Data Handling Module is used, certain Data Table words are set aside for Control/Status use and for file operations. In cases where this Module is used, pay particular attention to these reserved memory areas.

The PLC Processor Data Table may have one of 3 sizes:

- 256-word (addresses 000<sub>8</sub>-377<sub>8</sub>)
- 512-word (addresses 000<sub>8</sub>-777<sub>8</sub>)
- 1024-word (addresses 000<sub>8</sub>-1777<sub>8</sub>)

When transferring data between 2 PLC Processors, the smaller Data Table size dictates which addresses can be programmed at a sending station and accessed at a receiving station. This means that commands sent from a PLC Processor with a 256-word Data Table can only address Data Table locations 000<sub>8</sub>-377<sub>8</sub> at a remote station PLC Processor, even if that Processor has a 512- or 1024-word Data Table. Likewise, commands sent from a PLC Processor with a 512- or 1024-word Data Table can only access addresses 000<sub>8</sub>-377<sub>8</sub> at a station PLC Processor with a 256-word Data Table or addresses 000<sub>8</sub>-777<sub>8</sub> at a station PLC Processor with a 512-word Data Table.

#### 4.5.1 Input Image Table

When an Input Image Table word in the PLC Processor Data Table is unused, that is, has no corresponding input module in an I/O Rack, that word can be used for storage or control by commands. However, should an input module correspond to that word, the data in the word is updated from the input module each I/O scan;

this word cannot be used for storage or control by commands.

Note that this restriction does not prevent any word of the Input Image Table from being **written** to another station. This control restriction applies only when attempting to write data into Input Image Table locations.

#### 4.5.2 Word 377

Word 377 has special status functions with the PLC Processor. For this reason, the Communication Adapter Module is prevented from executing Write or Bit Write commands into the upper byte of this word (bits 10-17).

Word 377 at a remote station PLC Processor can be addressed by an Unprotected Read command from a local station.

#### 4.5.3 Word 000

Reserve Output Image Table word 000 when using the Communication Adapter Module. This means that both instructions in the user program and commands from any station must **not** address word 000 or any of its bits.

### 4.6 ACCESSIBLE DATA TABLE LOCATIONS — PLC-2 PROCESSORS

When it executes a Read, Write, or Bit Write command, the Communication Adapter Module controls Data Table locations at a station Processor. This Paragraph outlines the recommendations for control of Data Table locations in the following Processors:

- PLC-2/20 Processor
- PLC-2 Processor
- Mini-Processor Module

The Communication Adapter Module (Cat. No. 1771-KA) can execute Read, Write, or Bit Write commands to control any accessible Data Table words in any of these Processors. It also controls user-selected status words in the Data Table of these Processors. (Status words are described in Section 6.) Most Data Table words can be accessed by the Communication Adapter Module. However, certain memory areas in these Processors have special functions which preclude or prevent control of

these areas by the Communication Adapter Module. Data Table areas with a special function in these Processors are the following:

- Processor Work Areas
- Input Image Table
- Word 027

The limitations in controlling each of these areas are described in subsequent paragraphs. Access to all other Data Table areas is subject to the requirements of the programmer.

#### **4.6.1 Processor Work Areas**

The Processor Work Areas for PLC-2 Processors are addresses 000-007 and 100-107. These areas are used for specific Processor functions and are not accessible to commands from a station Communication Adapter Module. An attempt to write data into this area from a remote station Communication Adapter Module is prevented by the Processor. An attempt to read data from this area causes all 0's to be read.

Note that only Privileged commands, which can only be sent from a computer, may write into or read from this area of the Data Table.

#### **4.6.2 Input Image Table**

The Input Image Table areas for these Processors are addressed as follows:

- PLC-2/20 Processor: 110-147 <sup>1</sup>
- PLC-2 Processor: 110-127
- Mini-Processor Module: 110-117

This area of memory is updated each input scan. Any data written into this area, therefore, will be cleared on the next input scan. This limits the use of the Input Image Table as a value or bit storage area. Note, however that the Input Image Table may be read from or written to another station. This control restriction applies only when attempting to write data into the Input Image Table using a command from a Communication Adapter Module.

#### **4.6.3 Word 027**

Word 027 has a special function with each of these Processors. Bits 02710-02717 are used for Report Generation. Bit 02700 is used to indicate a low-battery condition for both the PLC-2/20 Processor and the Mini-Processor Module. Because of these special functions, care should be exercised in controlling word 027 with a Write or Bit Write command.

The Processor does not prevent data from being written to this Data Table word.

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<sup>1</sup> Using the Industrial Terminal System, the Input Image Table can be expanded in PLC-2/20 Processors from addresses 110-127 to 110-147. Refer to Memory Organization and Structure of PLC-2/20 Processors, Publication 1772-909.

## Section 5 COMMUNICATION ZONE RUNGS

### 5.0 GENERAL

In the ladder-diagram program, the user enters a special set of rungs which dictate Communication Adapter Module activity. This set of Communication Zone rungs is scanned by the Communication Adapter Module at power-up for the information it needs for operation.

For practical reasons, the Communication Zone rungs use the standard controller instruction set. However, the **meaning** of these instructions and addresses differs **significantly** from their meaning in standard ladder-diagram programming. For this reason, each programmed element in a Communication Zone rung must be understood as it is described in this Section, **not** as it would normally be understood in a ladder-diagram logic context.

In several instances, the 3- or 5-digit number entered above the Communication Zone rung element has no relation to an actual Data Table address. This Section specifically identifies this type of number as either a **Station No.** or **code**. Where one of these designations is given, the actual Data Table bit or word at that address is not affected by Communication Adapter Module operation and may be used in the balance of the user program.

For the purpose of this description, the reference point is termed the local station. All other stations are then considered remote stations. These rungs are entered at the local station so that it can send commands to, or receive commands from a remote station.

Obviously, this reference point is not fixed. Each station — as it is being programmed — is considered the local station at that time.

#### 5.0.1 Overall Format

The overall format for the Communication Zone of program is shown in Figure 5-1. This Figure shows each type of rung which can be entered in this Zone.

The actual Communication Zone rungs for any station Processor may vary significantly from those shown in Figure 5-1. The length of this program area is a function of the number of remote station Processors with which the local station Processor communicates and the number of transmissions of data with these remote stations.

Note that the order of these Communication Zone rungs is as follows:

1. Header rung
2. Memory Access rung(s) (as needed)
3. Command rung(s) (as needed)
4. Delimiter rung

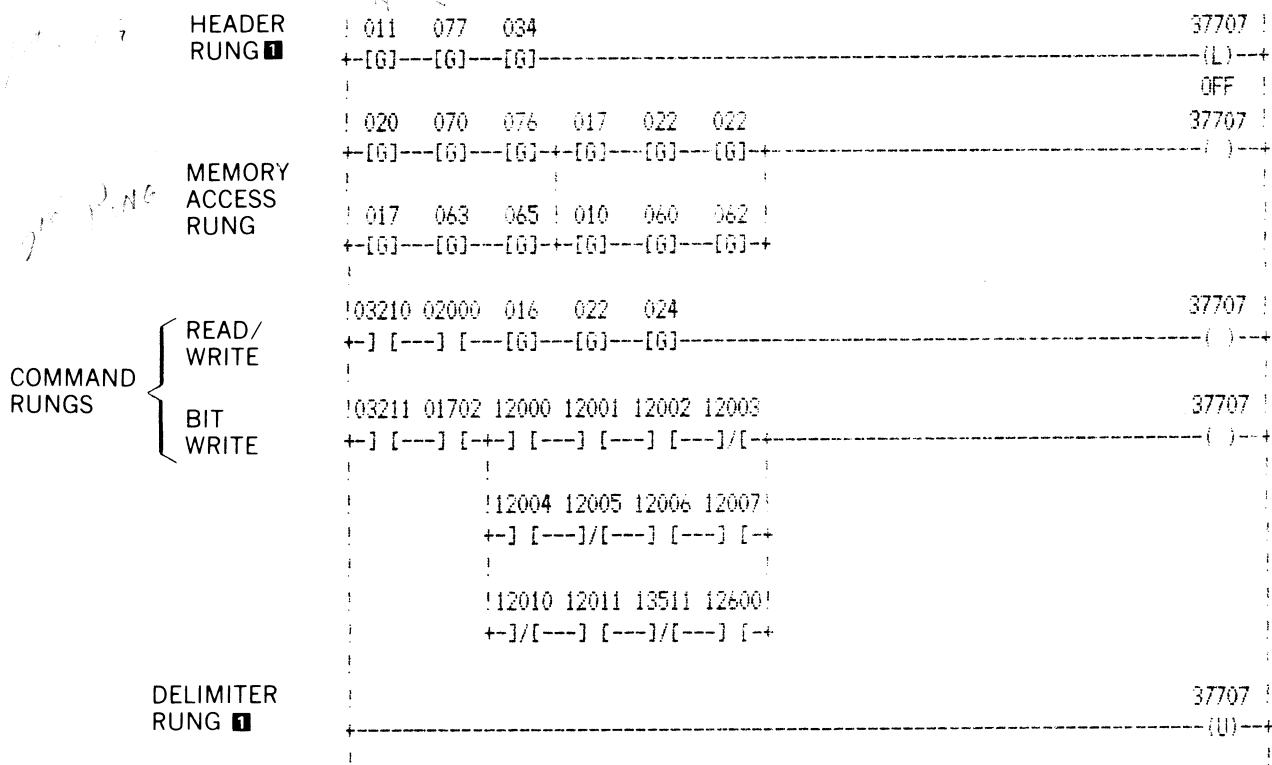
The Communication Zone rungs must always appear in this order.

As a minimum requirement, each station Processor must have a Header and a Delimiter rung. This provides the advantage of an ERROR CODE storage word, controlled by the Module as a diagnostic indicator.

The Communication Zone rung format shown in Figure 5-1 is essentially the same for both Communication Adapter Modules (Cat. No. 1771-KA and Cat. No. 1774-KA). However, the output instructions for Communication Zone rungs when using the Communication Adapter Module (Cat. No. **1771**-KA) address bit 02707 instead of bit 37707 in each rung.

Note that the Figures in this Section show the 3-digit addresses above most GET instructions, but not the 3-digit data value displayed below the GET symbol. This convention is used for clarity, since, for the most part, only the 3-digit GET **address** is significant when entering program. In entering Communication Zone rungs, no data need be programmed into the GET instructions.

A Communication Zone must be programmed for each Communication Adapter Module installed in a Processor. Where multiple zones are used, they must not overlap.



1 HEADER AND DELIMITER RUNGS ARE REQUIRED FOR EACH STATION PROCESSOR. MEMORY ACCESS AND COMMAND RUNGS ARE PROGRAMMED AS NEEDED

FIGURE 5-1 — Communication Zone Format (General)

## 5.1 HEADER RUNG

A Header rung, as shown in Figure 5-2, indicates the beginning of the Communication Zone. For the Communication Adapter Module (Cat. No. 1774-KA), the output instruction of this rung is always the LATCH 37707 instruction.

The 3 GET instructions in the Header rung list the following:

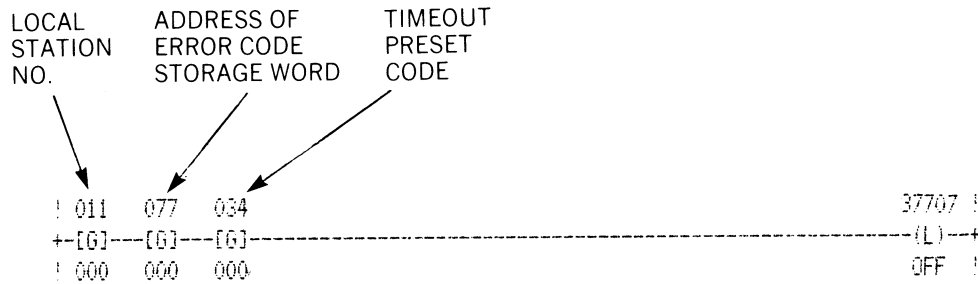
- Local Station No.
- Address of ERROR CODE storage word
- Timeout Preset Code

The local Station No. is a 3-digit number switch-selected on the Communication Adap-

ter Module. This number is an octal number from 010<sub>8</sub> to 077<sub>8</sub> or from 110<sub>8</sub> to 117<sub>8</sub>.

The ERROR CODE storage word is a status word in the Data Table of the local station Processor, controlled by the Communication Adapter Module. (The significance of this word is described in Paragraph 6.3)

The Timeout Preset Code gives a programmed timeout interval for command completion. Based on the 3-digit value entered in the address field of this GET instruction, the Communication Adapter Module monitors command execution for all commands sent from a station. In the examples of this Publication, the number 034 is entered as the Timeout Preset Code.



**FIGURE 5-2 — Header Rung**

This value, which designates a 5-second Timeout Preset, is suitable for most applications. The significance of this Preset Code, its computation, and timeout considerations are described in Paragraph 7.4.

## 5.2 MEMORY ACCESS RUNGS

The Memory Access rung defines Data Table words which can be accessed by the following commands:

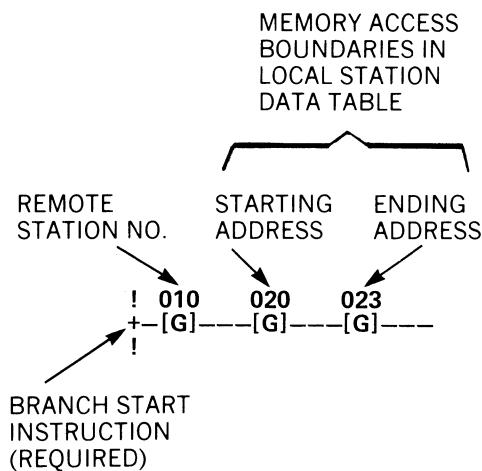
- Protected Write
- Protected Bit Write

Protected commands, received from a remote station, may control only those local station Processor memory areas listed in Memory Access rungs. (Note that Memory Access rungs

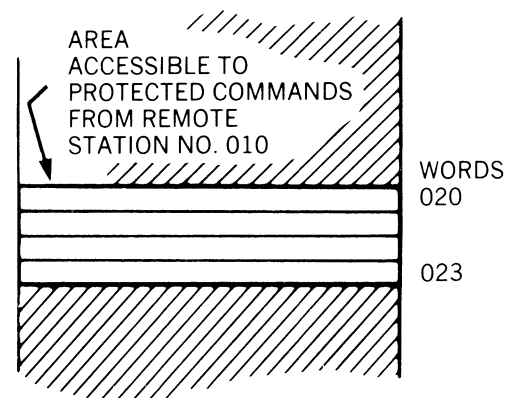
are not needed to allow Unprotected commands; only Protected commands require a Memory Access rung.)

A Memory Access rung is composed of one or more Memory Access branches, as shown in Figure 5-3(a). In this format, a BRANCH START precedes a group of 3 GET instructions. The first GET instruction address is the Station No. of a remote station. The next 2 GET addresses define the word boundaries of the accessible Data Table area in the local station Processor. The specified remote station may control any bit or word within these boundaries through Protected commands.

Figure 5-3(b) illustrates the memory area that is now accessible to Protected commands from remote station 010, due to the Memory Access branch of Figure 5-3(a).



**A. MEMORY ACCESS BRANCH**



**B. LOCAL STATION PROCESSOR DATA TABLE**

**FIGURE 5-3 — Memory Access Example**



Multiple Memory Access branches can be listed in a single Memory Access rung. Note that each group of 3 GET instructions **must** be preceded by a BRANCH START instruction. (This is true in all cases, even where only one Memory Access branch is defined.) BRANCH END instructions may be used to fit the Memory Access rung into the ladder-diagram display format.

The output instruction, OUTPUT ENERGIZE 37707, is used for the purpose of fitting the Memory Access rung into the proper display format. (This output instruction has no significance in Memory Access rung logic.)

Figure 5-4 shows a Memory Access rung with multiple branches. This rung lists the remote station which may control specific Data Table words using Protected commands, as follows:

- Station No. 020 can control words 070-076
- Station No. 017 can control words 063-065 and word 022
- Station No. 010 can control words 060-062

As shown in Figure 5-4, a single remote station Processor may be identified in more than one Memory Access rung branch.

For practical reasons, do not exceed the display area of the programming terminal when entering these rungs. More than one Memory Access rung can be programmed if needed.

Note, however, that should multiple Memory Access rungs be required, they must be entered in succession in the Communication

Zone, immediately following the Header rung and before any Command rung.

### 5.3 COMMAND RUNGS

The Command rungs direct the data transfer operations of the Communication Adapter Module. The Command rung lists the type of command and the memory areas affected and allows command execution to be initiated in the user program.

There are 2 general types of Command rung formats which differ only in terms of the unit of memory which they control. These Command rung formats are:

- Word command format
- Bit command format

The word command format is used for commands which transfer one or more Data Table words between stations. These are Unprotected Write, Unprotected Read, and Protected Write commands.

The bit command format is used for commands which control, from one station, one or more Data Table bits at another station Processor. These are Unprotected Bit Write and Protected Bit Write commands.

In both formats the Command rung begins in a similar manner. (Refer to Figure 5-5.) The first rung element is an EXAMINE ON instruction, addressing the START bit. The second rung element, termed the Command Code, tells the remote Station No., type, and priority of the

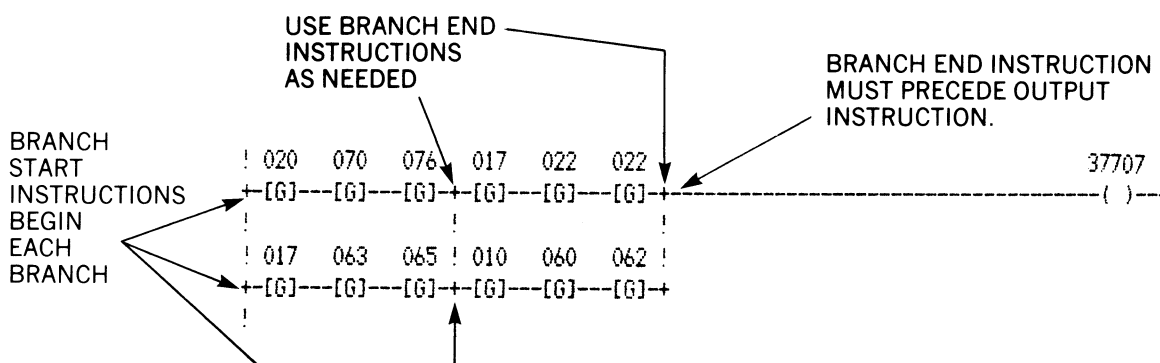
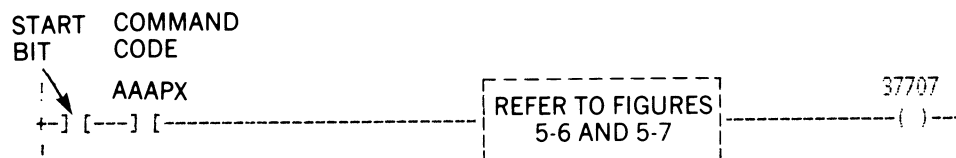


FIGURE 5-4 — Memory Access Rung (Typical)



| COMMAND CODE              |  |
|---------------------------|--|
| AAA — REMOTE STATION NO.  |  |
| P — PRIORITY INDICATOR    |  |
| 1 = PRIORITY MESSAGE      |  |
| 0 = NORMAL MESSAGE        |  |
| X — COMMAND TYPE          |  |
| 0 = PROTECTED WRITE       |  |
| 1 = UNPROTECTED READ      |  |
| 2 = PROTECTED BIT WRITE   |  |
| 3 = UNPROTECTED WRITE     |  |
| 4 = UNPROTECTED BIT WRITE |  |

**FIGURE 5-5 — Command Rung Format**

command. (Command priority is described in Section 8.)

After the Command Code, the Command rung then lists the memory areas affected by the command. The format of this area varies, based upon the type of memory area controlled by the command.

The Communication Zone may have up to 256 Command rungs. A unique Command rung is required for each command.

Each Command rung ends with an OUTPUT ENERGIZE 37707 element. This instruction is used solely for the purpose of fitting the Command rung into the proper display format. The output instruction of the Command rung has no significance in program logic.

### 5.3.1 Examine START Bit

Each Command rung has a unique START bit in a memory word selected by the programmer. The START bits are examined by the Communication Adapter Module. When a START bit is ON, the Communication Adapter Module carries out the programmed command.

The START bit is controlled by the program. This allows a command to be initiated only when necessary. (Programming methods for START bit control are given in Section 7.)

### 5.3.2 Command Code

The second element in a Command rung is termed the Command Code. The Command Code identifies the following:

- Remote Station No.
- Priority status of the command (Priority or normal)
- Type of command

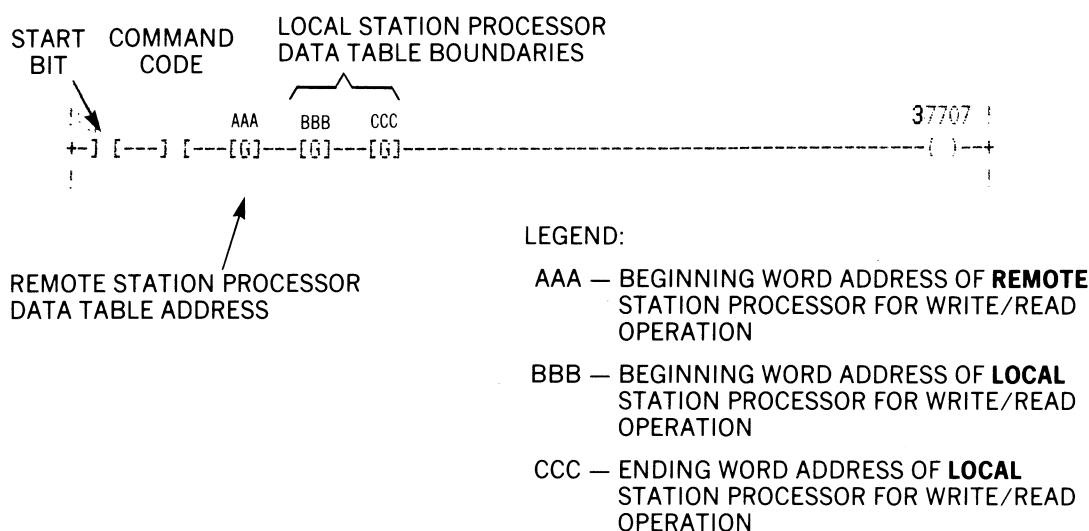
NOTE: The Command Code uses the address of an EXAMINE ON instruction, but does **not** examine or control any bit in the Data Table of the local station Processor.

Figure 5-5 shows the coding for this rung element.

### 5.3.3 Word Command Format

When the Command Code specifies a Protected Write, Unprotected Read, or Unprotected Write command, use the format shown in Figure 5-6.

This format uses 3 GET statements. The address position of the first GET statement lists a remote station Data Table word. The specified command operation begins at this memory location. The second and third GET statements list Data Table words in the local station Processor. These words are the beginning and



**FIGURE 5-6 — Word Command Format**

ending boundaries for the words to be transferred in the Write or Read operation.

In the Write operation, data words are written to a remote station from the local station Data Table. For a Write command, the first GET element in the Command rung lists a beginning address at the remote station. Data is to be written into this word, and succeeding words, from the local station Data Table. The second and third GET elements in this type of rung list the word or words to be written from the local station Data Table.

In the Unprotected Read operation, data words are read from a remote station Processor into the local station Data Table. The first GET element in the Unprotected Read Command rung lists the beginning address from which data is to be read. Remote Data Table words are read in succession, beginning with this address. Words are read only into the area of the local Data Table defined by the second and third GET elements in the rung.

Only one set of GET instructions, as shown in Figure 5-6, can be programmed in a single Command rung.

### 5.3.4 Bit Command Format

When the Command Code specifies a Protected Bit Write or Unprotected Bit Write

command, use the format shown in Figure 5-7.

This format uses EXAMINE elements which address bits in the remote station Processor. These elements control remote station Data Table bits as follows:

] [ EXAMINE ON — This rung element instructs the remote station Communication Adapter Module to turn the addressed bit ON.

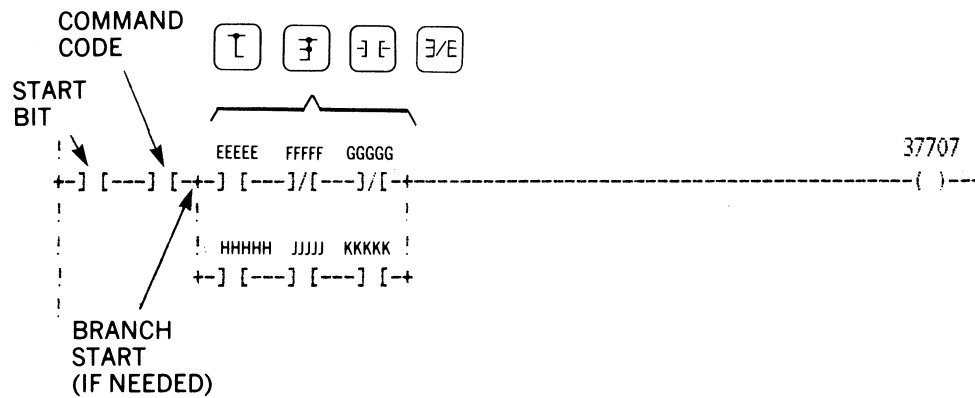
]/[ EXAMINE OFF — This rung element instructs the remote station Communication Adapter Module to turn the addressed bit OFF.

These elements are programmed immediately following the Command Code. Any combination of these elements may make up this type of Command rung. Where necessary, BRANCH START instructions and a BRANCH END instruction may be used to fit these elements into the display area of the programming terminal. For practical reasons, do not exceed this display area. Multiple rungs of this type can be used as necessary.

### 5.4 DELIMITER RUNG

The Delimiter rung ends the Communication Zone of program. With the PLC Processor, this rung always has the format shown in Figure 5-8.

AREA MAY CONTAIN ANY LEGAL COMBINATION OF  
THESE INSTRUCTIONS:



LEGEND:

EEEE  
 $\overline{L}$  [---] SET BIT EEEEE IN REMOTE STATION  
 DATA TABLE ON  
 FFFF  
 $\overline{F}$  [---] SET BIT FFFFF IN REMOTE STATION  
 DATA TABLE OFF

FIGURE 5-7 — Bit Command Format

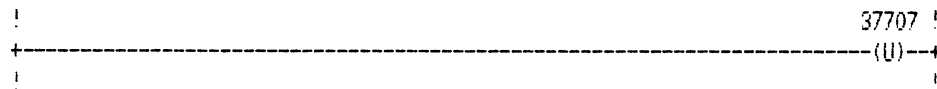


FIGURE 5-8 — Delimiter Rung

## Section 6 STATUS WORDS

### 6.0 GENERAL

The Communication Adapter Module controls certain Data Table words specified by the programmer in the local station Processor. These Data Table words indicate the status of command execution and provide various types of diagnostic information for start-up and troubleshooting. These locations are:

- One or more pairs of adjacent words for START/DONE and REMOTE/LOCAL FAULT bit storage
- An ERROR CODE storage word

Refer to Figure 6-1. The programmer specifies the locations of these status words when entering the Communication Zone rungs, as described in Section 5. A pair of START/DONE and REMOTE/LOCAL FAULT bit storage words is defined by the selection of the START bit in a Command rung. The ERROR CODE storage word is specified in the Header rung.

Any accessible Data Table words may be used as status words in the station Processor. Note that the same recommendations for Data Table control given in Paragraph 4.5 should be followed when selecting status words. That is, used Input Image Table words, word 377, and word 000 should not be used as status words.

NOTE: Where multiple Communication Adapter Modules are used in a single Processor, separate START/DONE, REMOTE/LOCAL FAULT, and ERROR CODE status words must be designated for each Module.

### 6.1 START/DONE WORD

The START/DONE word is the first of a pair of adjacent status words for Communication Adapter Module use. This word stores a START bit and corresponding DONE bit for each of up to 8 commands. (NOTE: should more than 8 Command rungs be programmed at a station, additional pairs of START/DONE and REMOTE/LOCAL FAULT words can be used.)

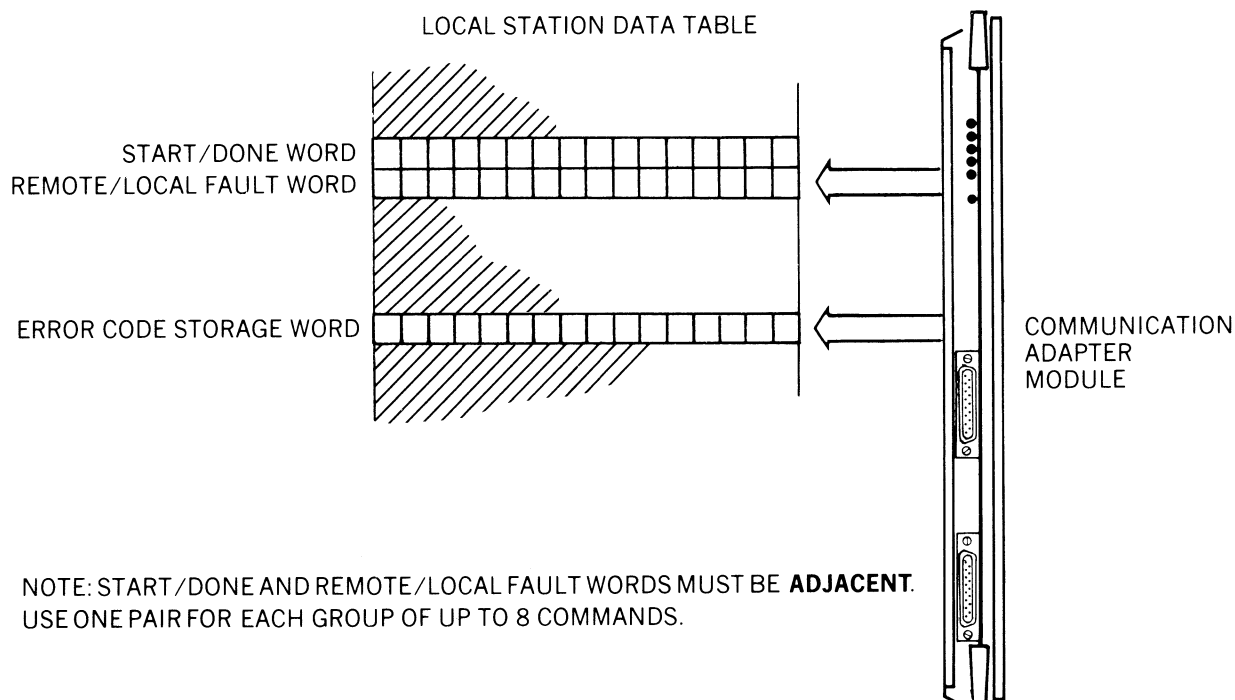


FIGURE 6-1 — User-Selected Status Words

The START bit for any command is always in the upper byte (bits 10-17) of the START/DONE word. The DONE bit for this command is then the corresponding bit in the lower byte (bits 00-07) of the same word.

In Figure 6-2(a) the sample Command rung examines bit 03210 as its START bit. As Figure 6-2(b) shows, the corresponding DONE bit is bit 03200. Note that the 5-digit addresses of START/DONE bits for each command differ only in the fourth digit: the START bit address always has a "1" in the fourth digit, the DONE bit address always has a "0".

As its name implies, the START bit initiates command execution. This bit, controlled by the user program, is set ON to initiate the sending of a command. The Communication Adapter Module monitors the status of START bits and executes the corresponding command when its START bit is set ON.

The DONE bit, as its name implies, indicates command completion. This bit, controlled by the Communication Adapter Module, is set ON when the execution of a command is completed.

Each Command rung examines a unique START bit. Thus, a single pair of START/DONE and REMOTE/LOCAL FAULT words has enough bits for up to 8 Command rungs. Should more Command rungs be programmed, select additional word pairs as necessary.

To optimize memory use and minimize the time required by the Communication Adapter Module to scan START bits, use all 8 START bits in one word pair before using another START/DONE word. For the same reason, group in sequential fashion all Command rungs which use the same START/DONE word.

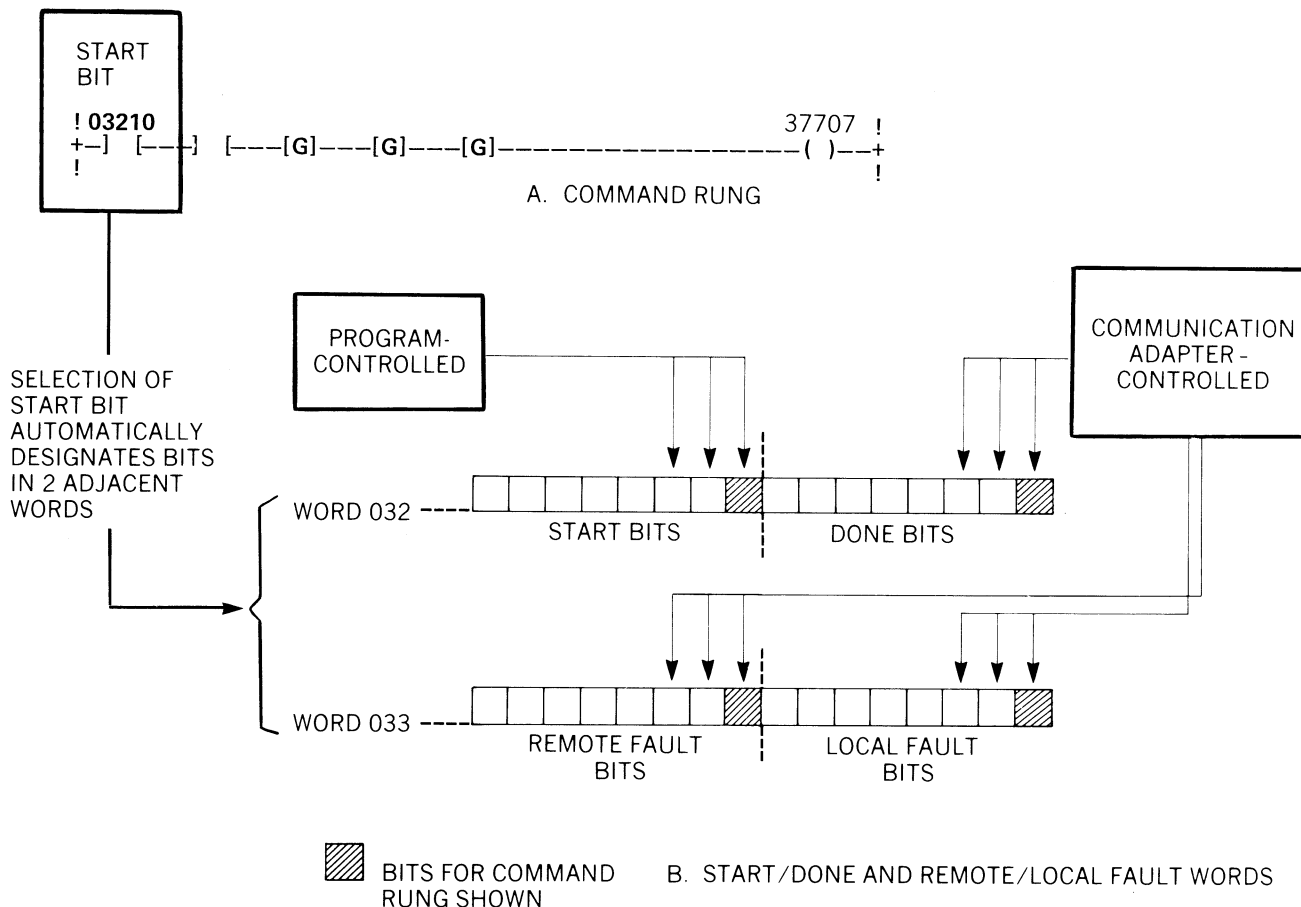


FIGURE 6-2 — Adjacent Status Words

## 6.2 REMOTE/LOCAL FAULT WORD

As Figure 6-2 shows, the selection of a START bit in the program not only causes a corresponding DONE bit to be controlled in that same word, but also causes REMOTE and LOCAL FAULT bits to be controlled in the next Data Table word. A REMOTE FAULT and LOCAL FAULT bit are controlled for each command. For a command, the position of each of these bits within their respective bytes corresponds directly to the position of START and DONE bits for that command.

REMOTE and LOCAL FAULT bits are controlled by the Communication Adapter Module. The Module sets a FAULT bit ON when a command cannot be executed due to a hardware-related fault either between stations or between the remote station Communication Adapter Module and its station Processor. Figure 6-3 summarizes the significance of these bits.

REMOTE FAULT bits are in the upper byte of this word, bits 10-17. A REMOTE FAULT bit is set ON when a command is received at a remote station but cannot be executed by a remote station. This may mean one of the following:

- Remote station Processor has detected a fault in its own operation or has shut down
- Cable between remote station Communication Adapter Module and Processor is disconnected or faulty (for Bulletin 1772 PLC-2/20 or PLC-2 Processors or Mini-Processor Module)
- Module switch setting prevents execution of the received command
- Error detected in Communication Zone of program at remote station Processor (PG indicator may be ON)

Note that a REMOTE FAULT bit indicates that the remote station Communication Adapter or Controller Module received a message, but could not communicate with its station Processor to execute that command.

LOCAL FAULT bits are in the lower byte of this word, bits 00-07. A LOCAL FAULT bit is set ON when a command cannot be received by a

remote station. This may mean one of the following:

- Automatic timeout of command completion by Communication Adapter Module
- Disconnection of the local or remote station interface Module from the Data Highway Cable
- Loss of power to the remote station Communication Adapter Module
- Unused Station No. addressed by the command.
- Excessive noise along the Data Highway Cable, caused by other equipment in the industrial environment

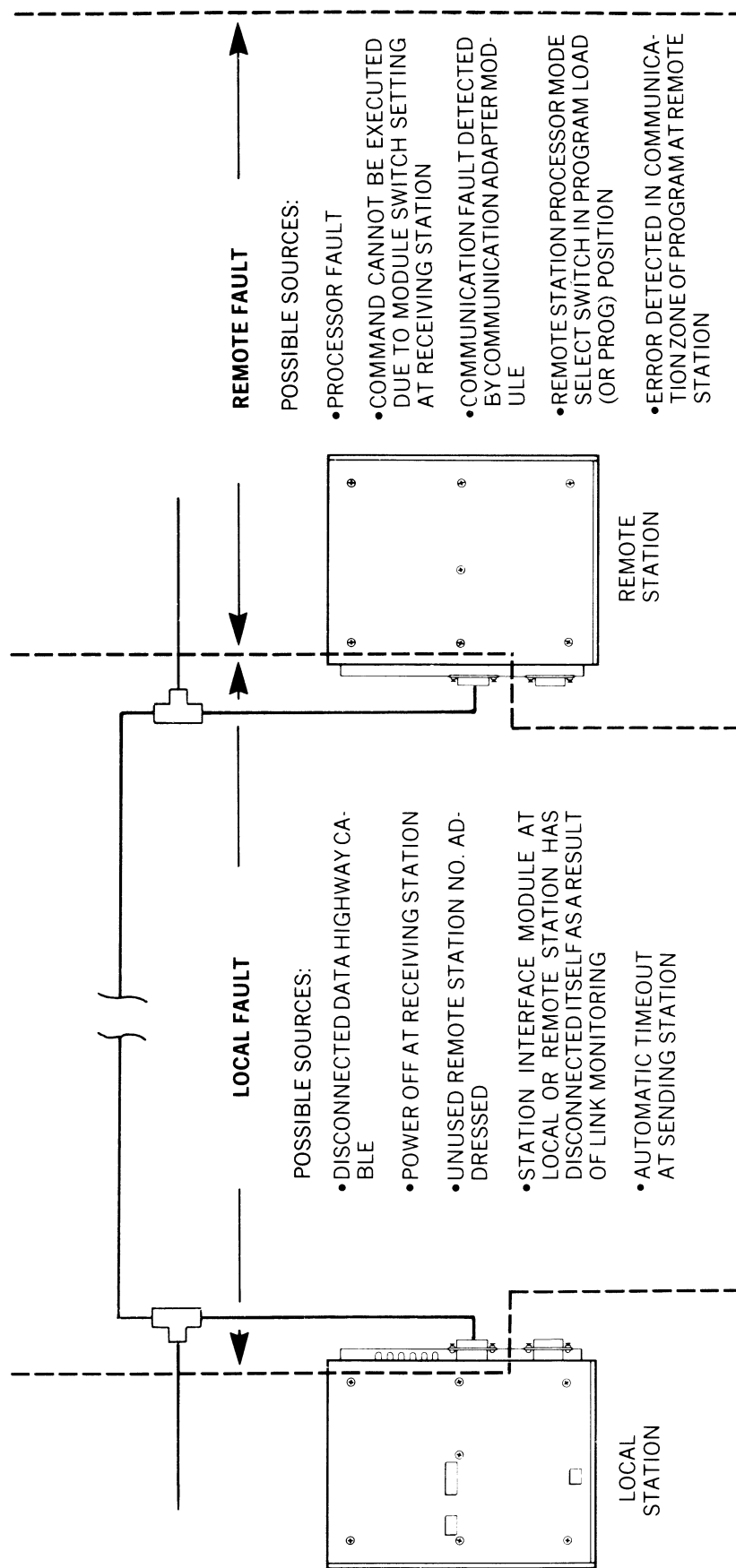
By monitoring these bits in the program, operator personnel can be alerted to hardware conditions which prevent normal transmission and execution of commands. (Programming techniques for monitoring FAULT bits are described in Section 7.)

At the same time it sets a REMOTE or LOCAL FAULT bit ON, the Communication Adapter Module enters a 2-digit ERROR CODE into the ERROR CODE storage word. (The ERROR CODE storage word is described in Paragraph 6.3.)

Note that REMOTE and LOCAL FAULT bits can also be set when sending a command to a station containing a Communication Adapter Module (Cat. No. 1771-KA). Because of the different hardware configuration for stations using this Module, FAULT bits may have a slightly different meaning for these stations. (Refer to the User's Manual, Publication 1771-801.) However, the **general** significance of these bits is the same for both types of stations: LOCAL FAULT bits are set ON if the command cannot be received; REMOTE FAULT bits are set ON if the command is received but cannot be executed.

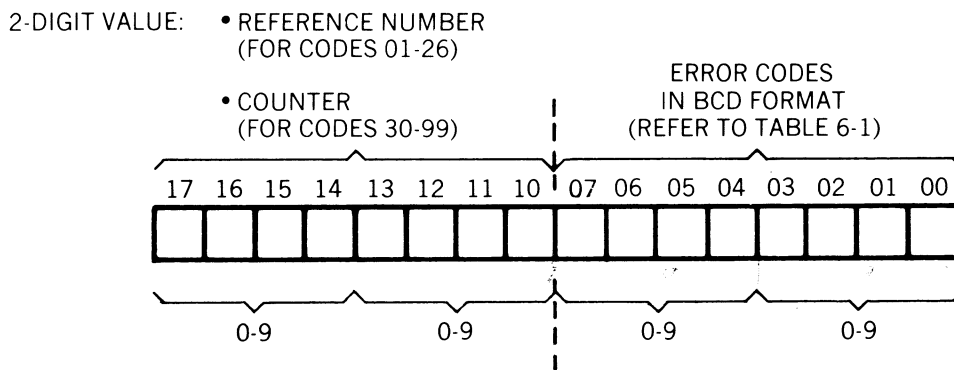
## 6.3 ERROR CODE STORAGE WORD

When a command cannot be carried out due to a user programming error or a discrepancy in data handled by the Communication Adapter Module, an ERROR CODE may be written into a Data Table memory word. The ERROR CODE



**FIGURE 6-3 — REMOTE/LOCAL FAULT Bit Significance**





**FIGURE 6-4 — ERROR CODE Word Format**

storage word is selected by the programmer and listed in the Header rung of the Communication Zone of program. This word stores the most recent ERROR CODE written by the Communication Adapter Module.

Figure 6-4 shows the structure of the ERROR CODE storage word. The lower byte of this word (bits 00-07) stores any ERROR CODE entered by the Module. In this byte the ERROR CODE is represented as a 2-digit BCD number from 00-99. Table 6-1 lists and describes these ERROR CODES.

ERROR CODES can be grouped as follows:

- Codes 01-26 generally indicate that some programming error has been detected in the Communication Zone of program. These codes are intended to indicate errors or Processor communication faults detected at power-up. The Program Status indicator (PROG) is ON if one of these codes is displayed.
- Codes 30-99 generally indicate that some programming or hardware related fault has been detected during attempts at communication between stations. These codes are intended to serve as diagnostic indicators after the initial power-up checks of program have been completed.

A code in this 30-99 group is displayed whenever a REMOTE or LOCAL FAULT bit is set ON.

The upper byte of the ERROR CODE storage word (bits 10-17) stores a 2-digit BCD value.

This value gives supplemental error or fault information, depending on the type of ERROR CODE displayed. It may have one of two meanings:

- Reference number
- Counter

For ERROR CODES 01-26, the upper byte stores a 2-digit reference number. This number points to the location of a programming error within the Communication Zone of program. This error may be an incorrect instruction or an improper address entered within a rung of the Communication Zone. In this numbering scheme, the Header rung of the Communication Zone of program is designated as "00". Subsequent Communication Zone rungs are numbered sequentially.

Note that ERROR CODES 01-26 are intended as aids in start-up debugging of the Communication Zone of program. Thus, the reference number stored in this word can be a valuable tool for debugging purposes.

For ERROR CODES 30-99, the upper byte stores a 2-digit counter. This counter shows the number of ERROR CODES 30-99 written into the storage word by the Communication Adapter Module. The counter increments each time a different ERROR CODE is entered by the Module.

Because CODES 01-26 are intended for start-up situations and CODES 30-99 are intended for situations subsequent to power-up, there is

**TABLE 6-1 — ERROR CODE Listing**

| <b>CODE</b>                      | <b>MEANING</b>                                                                                                         |
|----------------------------------|------------------------------------------------------------------------------------------------------------------------|
| 01,02                            | Processor communications problem. May be Processor Fault                                                               |
| 03                               | No memory in Communication Adapter Module for START bit file                                                           |
| <b>MEMORY ACCESS RUNG FORMAT</b> |                                                                                                                        |
| 04                               | First GET instruction incorrectly entered                                                                              |
| 05                               | Invalid Station No.                                                                                                    |
| 06                               | Second GET instruction incorrectly entered                                                                             |
| 07                               | Third GET instruction incorrectly entered                                                                              |
| 08                               | Third GET address less than second GET address (improper Access boundary definition)                                   |
| 09                               | Invalid end of Access branch (BRANCH END instruction must be inserted.)                                                |
| 10                               | Invalid end of Access rung                                                                                             |
| 11                               | Beginning of next rung invalid. (Refers to any rung after a Memory Access rung.) Or, BRANCH START instruction missing. |
| <b>COMMAND RUNG FORMAT</b>       |                                                                                                                        |
| 12                               | START bit in lower byte. (START bit must be selected from upper byte, bits 10-17.)                                     |
| 13                               | Second EXAMINE element incorrectly entered                                                                             |
| 14                               | Invalid Command Code                                                                                                   |
| 15                               | Invalid remote Station No. in Command Code                                                                             |
| 16                               | Invalid element in Bit Write rung                                                                                      |
| 17                               | First GET incorrectly entered (Word command format)                                                                    |
| 18                               | Second GET incorrectly entered (Word command format)                                                                   |
| 19                               | Third GET incorrectly entered (Word command format)                                                                    |
| 20                               | End of rung incorrectly entered (Word command format)                                                                  |
| 21                               | Beginning of new Command rung invalid or Memory Access rung programmed following Command rung.                         |
| 22                               | REMOTE/LOCAL FAULT word not in Data Table. (START/DONE word incorrectly chosen.)                                       |
| 23                               | Unprotected command not allowed by switch setting at local station.                                                    |
| 26                               | Excessive number of Command rungs (more than 256).                                                                     |

**COMMUNICATIONS ERRORS**  
**(MAY BE DISPLAYED IN CONJUNCTION WITH REMOTE/LOCAL FAULT BITS)**

|    |                                                                                                                                                                                                                                                                        |
|----|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 30 | Processor memory discrepancy                                                                                                                                                                                                                                           |
| 31 | Controller communications problem. May be Processor fault.                                                                                                                                                                                                             |
| 32 | Improper command message size                                                                                                                                                                                                                                          |
| 33 | Invalid Command Code                                                                                                                                                                                                                                                   |
| 34 | Invalid Station No.                                                                                                                                                                                                                                                    |
| 35 | Attempt to send Unprotected command invalid                                                                                                                                                                                                                            |
| 36 | Command execution aborted by sending station Processor                                                                                                                                                                                                                 |
| 37 | Command execution aborted. Execution time exceeds Timeout Preset value.                                                                                                                                                                                                |
| 50 | Processor communications problem. May be Processor fault.                                                                                                                                                                                                              |
| 51 | Invalid Transparent word in reply message.                                                                                                                                                                                                                             |
| 52 | No Communication Zone rungs in program                                                                                                                                                                                                                                 |
| 53 | Reply not expected. (Reply received, but START bit is OFF.)                                                                                                                                                                                                            |
| 54 | Processor memory not in format for communication                                                                                                                                                                                                                       |
| 55 | Invalid reply. (Reply received, but Communication Zone rungs are incorrectly entered. Or, reply received when Processor Mode Select keylock switch is in the PROGRAM LOAD position.) Program Status indicator (PG) may be ON to indicate this type of error condition. |
|    | May mean Memory Access rung missing for received Protected command.                                                                                                                                                                                                    |
| 56 | Incorrect sequence number in reply. (Refers to Transparent word in message format.)                                                                                                                                                                                    |
| 81 | Illegal command                                                                                                                                                                                                                                                        |
| 82 | Station Processor communication problem.                                                                                                                                                                                                                               |
| 83 | Remote station Processor faulted or OFF.                                                                                                                                                                                                                               |
| 84 | I/O Fault at remote station Processor.                                                                                                                                                                                                                                 |
| 85 | Transmitted command disallowed by switch setting or Memory Access rung programming at remote station.                                                                                                                                                                  |
| 86 | Transmitted command disallowed by switch setting at remote station.                                                                                                                                                                                                    |
| 87 | Remote station Processor in PROG or PROGRAM LOAD mode.                                                                                                                                                                                                                 |
| 88 | Communication Zone invalid at remote station Processor. Program Status indicator (PROG) may be ON at that station.                                                                                                                                                     |
| 89 | Remote station Communication Adapter Module unable to buffer received command in memory.                                                                                                                                                                               |
| 92 | Destination station fails to respond.                                                                                                                                                                                                                                  |
| 93 | Contention between master stations prevents message transmission.                                                                                                                                                                                                      |

no conflict in controlling this upper byte of the ERROR CODE storage word.

These codes are generally to be displayed on a programming terminal rather than used in application programming. They have special value in station start-up, when programming errors are detected in the Communication Zone of program. By viewing the Header rung of the Communication Zone, the programmer can examine a displayed ERROR CODE and the

least significant digit of the counter in this word. (The Header rung is described in Section 5.)

In some instances, however, it may be preferable to display the 2-digit error code using a 7-segment BCD numerical display controlled from output modules of the Controller. This 7-segment display, mounted at an operator's station, can provide a useful troubleshooting aid for quickly locating fault conditions.

## Section 7 COMMAND INITIATION, EXECUTION, AND MONITORING

### 7.0 GENERAL

This Section describes the support programming for commands at each station Processor. This programming uses the START/DONE and REMOTE/LOCAL FAULT bits, described in Section 6, to initiate and monitor command execution. Using these recommended techniques, the programmer coordinates Communication Zone programming with his application program.

### 7.1 START/DONE/FAULT BIT TIMING

The START bit which initiates a command is user program-controlled; the DONE bit, which indicates command completion, is Communication Adapter Module-controlled. The timing relationship of START and DONE bits is used by the programmer to initiate and terminate commands. The following paragraphs describe this relationship in normal operation and describe the automatic responses which result from faulted operation.

#### 7.1.1 Normal Operation

Command execution begins when the user program turns a START bit ON, normally with a LATCH instruction. The Communication Adapter Module detects the ON state of this bit and then begins the operations necessary to format and transmit a command message.

When the remote station Communication Adapter Module receives the command message, it acknowledges it. Then, while normal Data Highway operation continues, the remote station Communication Adapter Module executes the command and prepares a reply message. (A reply message is sent for each type of command.) The remote station Communication Adapter Module responds to a poll for mastership, then transmits its reply message to the local (sending) station. (Refer to Section 8 for a description of mastership and polling.)

When the local station Communication Adapter Module receives the reply, it sets the DONE bit ON at the local station Processor. The DONE bit, in turn, is examined in the user program to turn OFF the START bit.

After the START bit has been turned OFF (unlatched), the Communication Adapter Module resets the DONE bit.

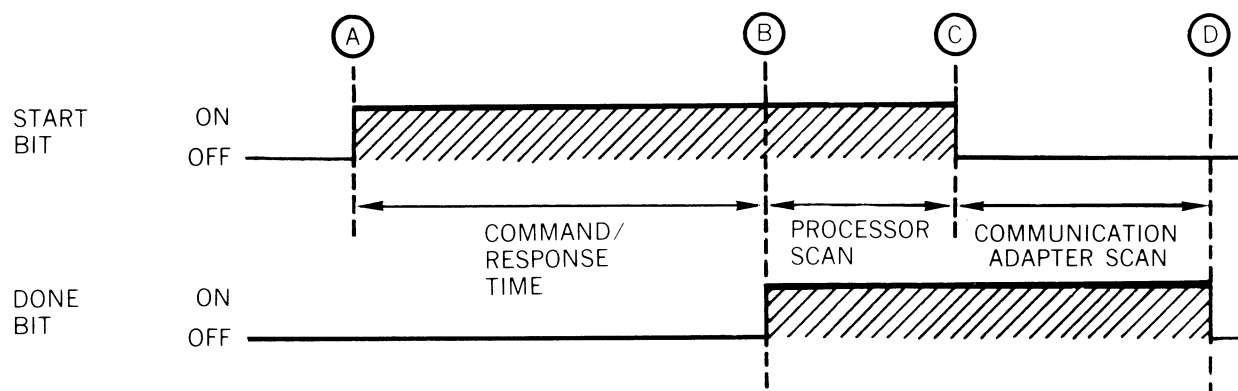
The timing of START and DONE bits for a command is shown in Figure 7-1. The significance of START/DONE bit status is summarized in Table 7-1.

#### 7.1.2 Faulted Operation

Certain fault conditions can prevent normal reception and execution of commands by the receiving station. To indicate the source of

**TABLE 7-1 — START/DONE Bit Status**

| STATUS    |          | SIGNIFICANCE                                                                                                                                                                                |
|-----------|----------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| START BIT | DONE BIT |                                                                                                                                                                                             |
| 0         | 0        | Idle                                                                                                                                                                                        |
| 1         | 0        | Command initiated or in progress                                                                                                                                                            |
| 1         | 1        | Command/reply operation complete.                                                                                                                                                           |
| 0         | 1        | The Processor, based on the program, acknowledges completion of the command/reply operation (Transient condition, since the Communication Adapter turns the DONE bit OFF in its next scan.) |



LEGEND:

- Ⓐ START BIT TURNED ON BY THE PROGRAM
- Ⓑ DONE BIT SET ON BY THE COMMUNICATION ADAPTER MODULE TO INDICATE THAT A COMMAND HAS BEEN COMPLETED.
- Ⓒ START BIT TURNED OFF BY THE PROGRAM
- Ⓓ DONE BIT SET OFF BY THE COMMUNICATION ADAPTER MODULE AFTER IT SENSES THAT THE START BIT HAS BEEN SET OFF.

**FIGURE 7-1—START/DONE Bit Timing—Normal Operation**

such fault conditions, the Communication Adapter Module controls REMOTE and LOCAL FAULT bits at the station Processor.

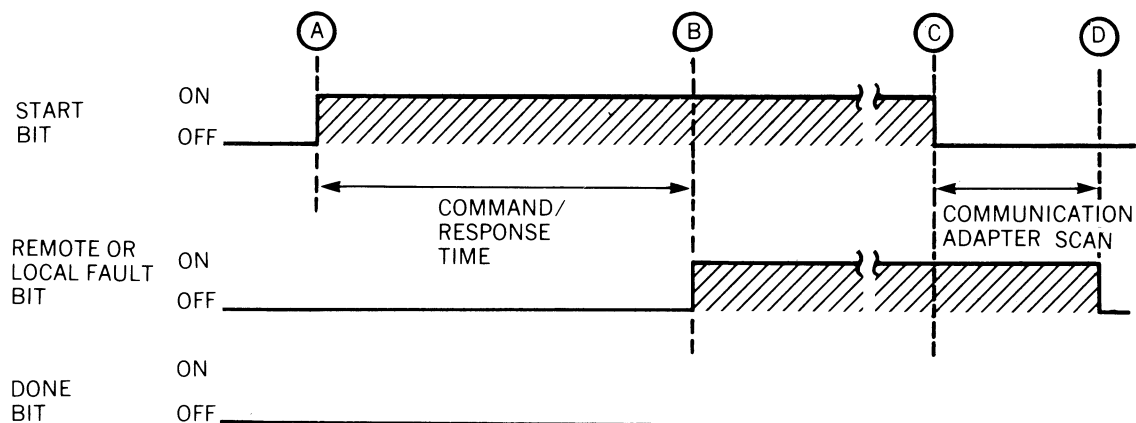
In general, the LOCAL FAULT bit indicates that the intended receiving station is unable to receive a command message addressed to it. The REMOTE FAULT bit, on the other hand, indicates that the intended receiving station Communication Adapter Module has received the command message, but is unable to execute the command at its station Processor. (For a quick summary of the distinction between these FAULT types, refer to Figure 6-3.)

The timing relationship of these FAULT bits in command execution is shown in Figure 7-2. In this example, the command initiated at the

setting of the START bit cannot be executed due to some fault condition. The Communication Adapter Module, detecting this fault condition, sets either a LOCAL or REMOTE FAULT bit.

Recall that the START bit is program-controlled. The REMOTE/LOCAL FAULT bits, meanwhile, are Communication Adapter Module-controlled. The programmer must keep this relationship in mind when planning START bit control and FAULT bit monitoring in the ladder-diagram program.

Note from Figure 7-2 that the FAULT bit, once ON, remains ON until the START bit is reset (turned OFF). Only after it has detected that the program-controlled START bit is OFF does the Communication Adapter Module then turn



LEGEND:

- (A) START BIT TURNED ON BY THE PROGRAM
- (B) REMOTE FAULT OR LOCAL FAULT BIT SET ON BY THE COMMUNICATION ADAPTER MODULE TO INDICATE THAT A FAULT CONDITION HAS BEEN DETECTED
- (C) START BIT TURNED OFF BY PROGRAM
- (D) FAULT BIT TURNED OFF BY THE COMMUNICATION ADAPTER MODULE AFTER IT SENSES THAT START BIT HAS BEEN TURNED OFF

**FIGURE 7-2—START/FAULT Bit Timing—Faulted Operation**

the FAULT bit OFF. Note also that the DONE bit may not be set ON in the event of a fault condition.

Note: In the special case where the START bit is turned OFF by the program before the Communication Adapter Module sets a DONE or FAULT bit, attempts to send that command are terminated. The LOCAL FAULT bit is pulsed ON for approximately 60 msec in this instance. This type of situation may occur, for example, if some event is programmed to UNLATCH the START bit before command completion.

## 7.2 CONTROLLING THE START BIT

The user program controls the START bit, setting it ON to initiate command execution, turning it OFF after command completion or after a fault is detected. Normally, the START bit is turned ON by a LATCH instruction, OFF by an UNLATCH instruction. The use of retentive LATCH/UNLATCH instructions is best suited for the START/DONE/FAULT bit timing

relationship and helps to keep programming simple and straightforward.

To LATCH the START bit, the program examines application conditions. These may include input/output device data, values, or other information from the controlled process. For the most part, an application condition used to initiate a command is one of these general types:

- ON or OFF status of some I/O device
- Transition of some I/O device
- Timed condition

To UNLATCH the START bit, the program examines the response from the Communication Adapter Module. This response may be one of the following:

- DONE Bit
- REMOTE FAULT bit

- LOCAL FAULT bit

Thus, the rung which is used to UNLATCH the START bit examines these three possible responses in parallel branches of the ladder diagram program.

Paragraphs 7.2.1 through 7.2.3 describe the most commonly used forms of START bit control. Each paragraph describes a different method for initiating command execution; all examples show how the program uses both DONE and FAULT bits to UNLATCH the START bit.

An important assumption underlies the examples outlined in paragraphs 7.2.1 through 7.2.3 and shown in Figures 7-3 through 7-5. Here, the program automatically retries transmission of a command in the event of a fault. Only the DONE bit terminates attempts at command execution; a LOCAL or REMOTE FAULT bit response causes the program to re-initiate command execution. (This type of programmed retry is not to be confused with the retry procedure of the Communication Adapter Module itself; transparent to user programming, the Communication Adapter Module automatically attempts 8 retries of a message before it sets a FAULT bit. Paragraph 8.1 describes these automatic retries of the Module.)

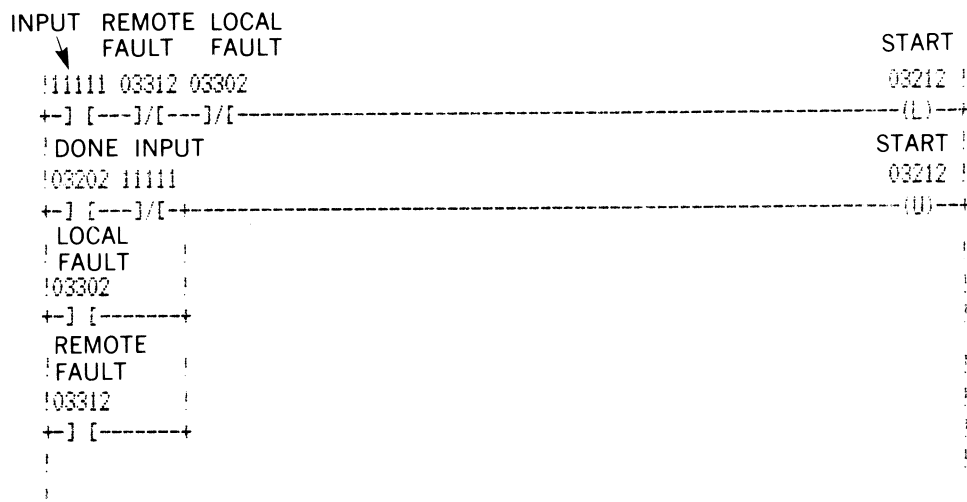
Programmed retry has distinct advantages. As the Communication Adapter Module continuously tries to send the command message, any data content of the message (for a Write command) is continuously updated. As soon as the fault condition is corrected, the message is sent with the latest data. In addition, once the command is completed, the program automatically UNLATCHES the START bit. This eliminates the need for a manual reset of the START bit when a fault condition is corrected.

### 7.2.1 ON/OFF Input Status

The ON or OFF status of an input device can be used to LATCH the START bit. Figure 7-3 shows example rungs for this type of command initiation.

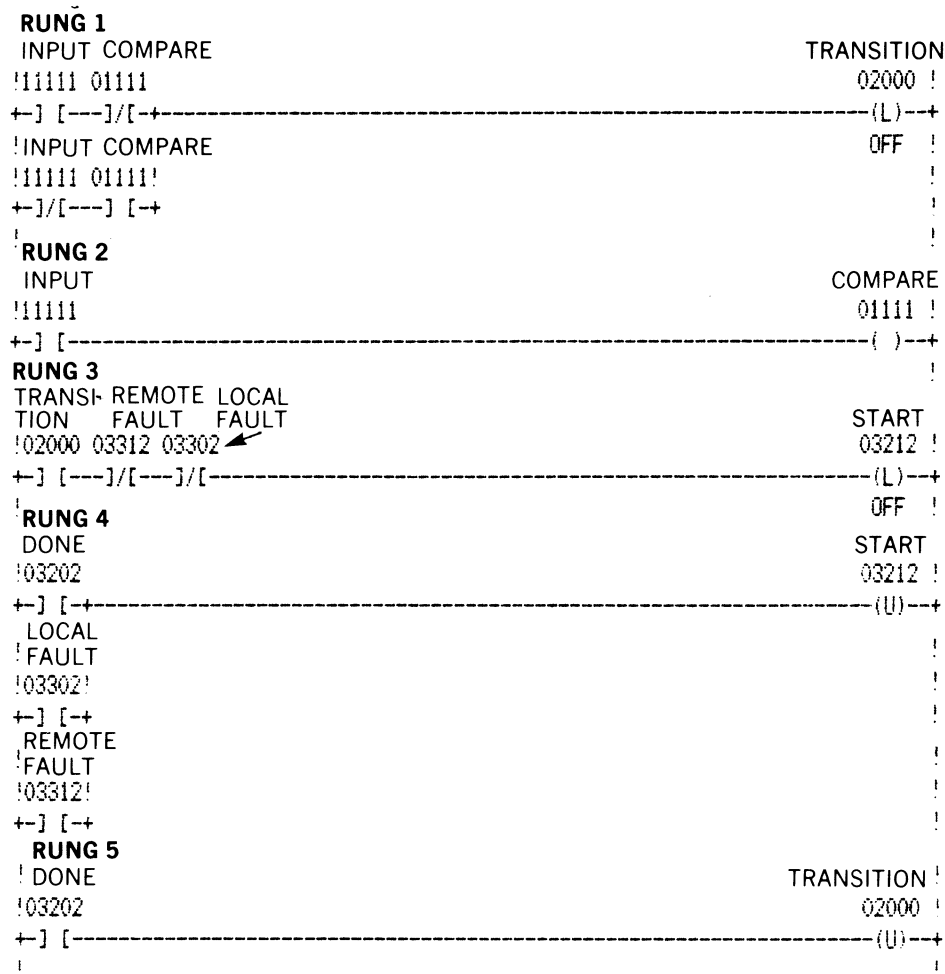
In this example, the first rung is programmed to LATCH the START bit when the input, bit 11111, is ON, provided that both FAULT bits are OFF. The second rung is programmed to UNLATCH the START bit based on the response of the Communication Adapter Module.

In normal operation, the START bit is LATCHED by the input 11111; the FAULT bits, initially, are OFF. This causes the command message to be formatted and sent. Then, when the command is completed, the DONE bit is set ON by the Communication Adapter Module.



### FIGURE 7-3—Status-Initiated Command





**FIGURE 7-4—Transition-Initiated Command**

Note that the input bit, 11111, must also be OFF to UNLATCH the START bit in this example. With this arrangement, the command message is sent only once; input 11111 must be turned OFF, then ON again, to execute this command a second time. In normal operation, the START bit, after successful command completion, remains ON until input 11111 goes OFF. (Recall from Figure 7-1 that the Communication Adapter Module holds the DONE bit ON until after the START bit is turned OFF.)

Should a fault condition prevent normal execution, these rungs provide a programmed retry of the command. A REMOTE or LOCAL FAULT bit resets the START bit in the second rung. In the first rung, the START bit is LATCHED again after the Communication Adapter Module resets the FAULT bit. (As Figure 7-2 shows, the Module resets a FAULT bit only after the

START bit has been turned OFF.)

Even though the FAULT bits are continually reset with this method, their usefulness must not be overlooked. Paragraph 7.3 outlines a useful method to monitor FAULT bits and control an output indicator based on FAULT bit status.

In some applications, it may be useful to send a command continuously between stations. With the example of Figure 7-3, this can be accomplished by eliminating the EXAMINE OFF instruction for input 11111 in the second rung. This would cause the command to be sent continuously as long as input 11111 remains ON.

### 7.2.2 Transition

The transition of an input device from ON to OFF and from OFF to ON can be used to LATCH

the START bit. This allows a command to be sent each time a condition changes state. Figure 7-4 shows example rungs for this type of command initiation.

In this example, a storage bit, called the "transition" bit, is manipulated to control the sending of the command. This bit is LATCHED whenever a transition of input 11111 is detected, UNLATCHED only when the DONE bit is set ON. A "compare" bit, 01111 in this example, is used to manipulate the transition bit. In Rung No. 2, the compare bit is controlled to match the ON/OFF status of the input. Because the input and the compare bit are programmed to have matching states, both ON or both OFF, the conditions of RUNG No. 1, can be TRUE only when the input has just changed from ON to OFF or from OFF to ON. Thus, Rung No. 1 conditions set up a "one-shot", true only long enough to LATCH the transition bit. Note that these rung conditions are FALSE as soon as the Processor scans Rung No. 2. The order of these rungs is important for this reason.

With the transition bit LATCHED, the START bit, in turn, is LATCHED in Rung No. 3. This initiates the command. In normal operation, the DONE bit UNLATCHES the START bit in Rung No. 4 and then UNLATCHES the transi-

tion bit in Rung No. 5. In faulted operation, however, Rungs No. 3 and 4 repeatedly retry the command in much the same manner as in the example of Figure 7-3.

### 7.2.3 Timed

The START bit can be LATCHED periodically to send a command at a user-determined time interval. Figure 7-5 shows example rungs for this type of command initiation.

In this example, timed bit 24615 is used to initiate the command at every Preset interval, 10 seconds. This bit is examined to LATCH the START bit. The DONE, LOCAL FAULT, and REMOTE FAULT bits are examined in parallel branches to UNLATCH the START bit.

In normal operation, after the command is executed, the DONE bit is set ON by the Communication Adapter Module. This causes the program to UNLATCH the START bit. The timer then begins timing again once the DONE bit is set OFF. (As Figure 7-1 shows, the DONE bit is reset only after the START bit is reset.)

Note that this programming causes continuous retry of a command in the event of faulted operation.

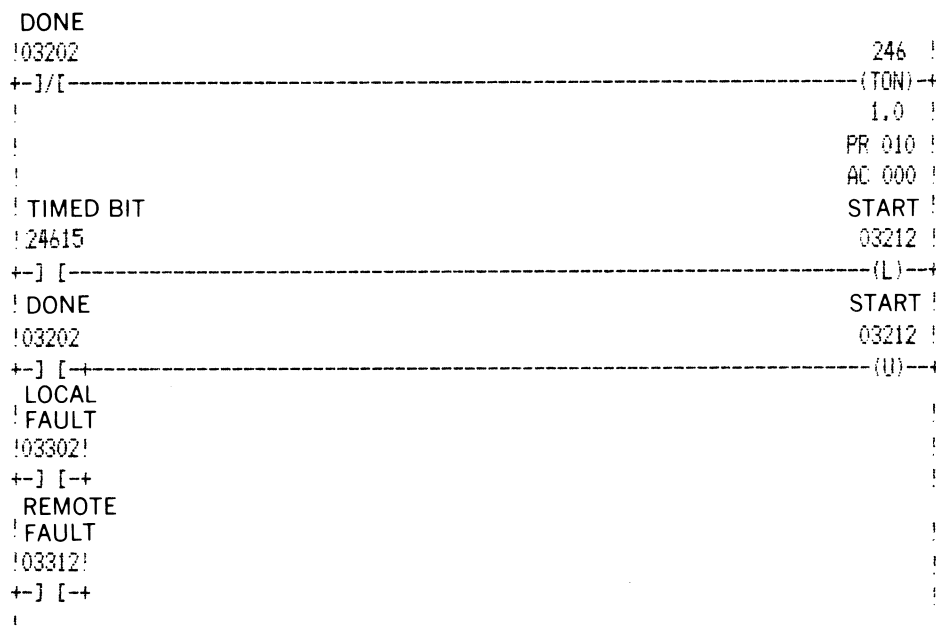


FIGURE 7-5—Timer-Initiated Command

### 7.3 REMOTE/LOCAL FAULT BIT MONITORING

When it cannot execute a command, the Communication Adapter Module sets a REMOTE or LOCAL FAULT bit ON. These bits, in the Data Table of the station Processor, are located in the word immediately following the START/DONE bit word. They indicate not only that a command was not executed, but also point to the general type of fault condition which prevented command completion.

The user program must monitor the REMOTE and LOCAL FAULT bits for each command. The recommendations of this Paragraph describe two methods for monitoring FAULT bits and using these bits to signal a fault condition.

### 7.3.1 Diagnostic FAULT Rungs

The purpose of REMOTE/LOCAL FAULT bit monitoring is to control one or more output indicators to signal a fault condition. Fault indicators controlled for this purpose may be as simple as a warning light or annunciator or as complex as a line printer or CRT terminal used to display a fault message. By controlling the fault indicator device, the user program can alert user personnel to the nature and location of a fault condition.

In order to monitor the REMOTE and LOCAL FAULT bits, the programmer must understand their timing relationship to the corresponding START bit. Figure 7-2 summarizes this relationship.

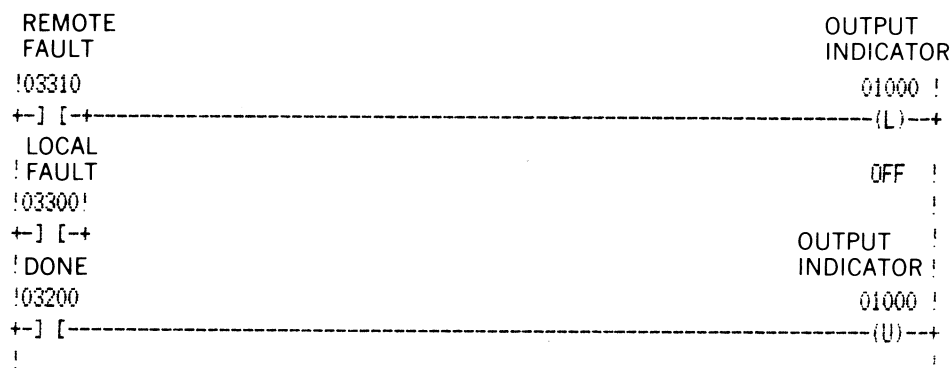
Paragraph 7.2 showed how the FAULT bits can be programmed to UNLATCH the START bit in

a fault situation and thus provide automatic retries through the program. When used in this manner, however, a FAULT bit will be rapidly cycled ON and OFF if a fault is detected. Because the FAULT bit can be constantly changing state at a rapid rate, the program must use some method of detecting this transient state of any FAULT bit and controlling the output device based on this state.

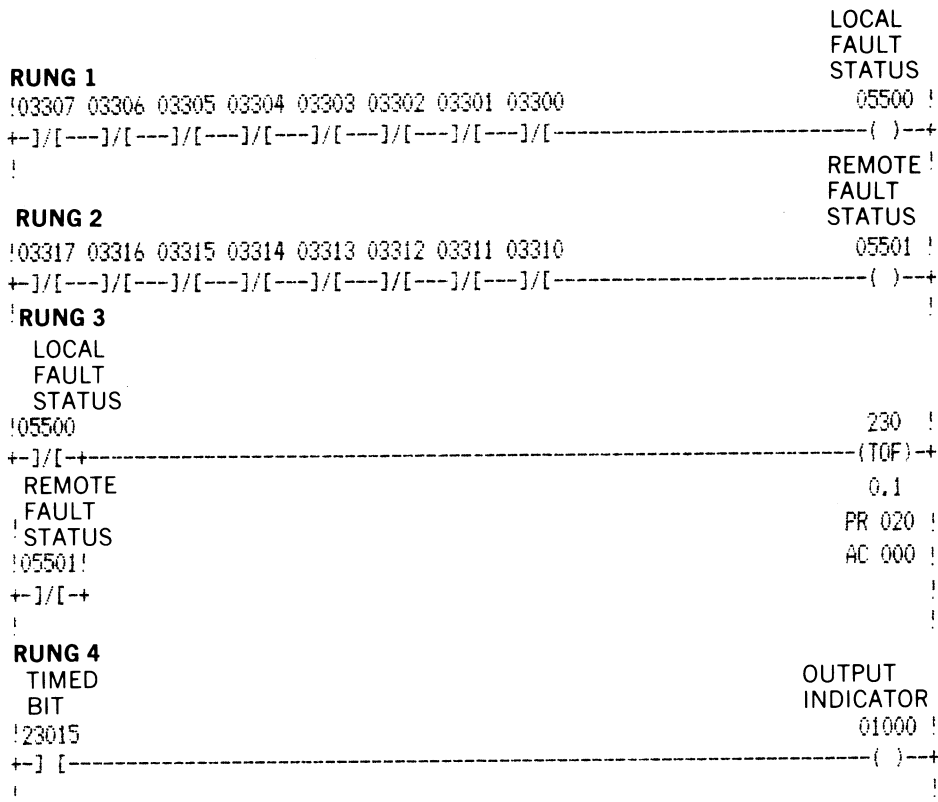
Figure 7-6 shows a simple method for the control of a fault indicator. Here, either the REMOTE or LOCAL FAULT bit can LATCH the output indicator ON. The indicator remains ON until the DONE bit is energized. This then UNLATCHES the output indicator in the second rung of Figure 7-6. This example allows for the transience of the FAULT bits, since the first rung need only be TRUE once for the output indicator to be latched.

The method of Figure 7-6 can be extended to monitor multiple commands from a station, controlling multiple output indicators as necessary. However, where more than one command is being sent from a station, the use of multiple output indicators may not be practical. In this instance, a single output indicator can be used to signal all REMOTE or LOCAL FAULT conditions for commands from that station. Figure 7-7 shows a method for fault indicator control assuming multiple commands.

This example shows the FAULT bit monitoring



### FIGURE 7-6—FAULT Bit Diagnostic Rungs (Single Command Example)



**FIGURE 7-7—Fault Bit Diagnostic Rungs (Multiple Commands Example)**

for 8 commands. The 8 LOCAL FAULT bits are monitored in Rung No. 1. As long as all 8 bits are OFF, status bit 05500 remains ON. However, should any LOCAL FAULT bit be ON, status bit 05500 is de-energized. In Rung No. 2, the 8 REMOTE FAULT bits are monitored in the same manner, to control status bit 05501.

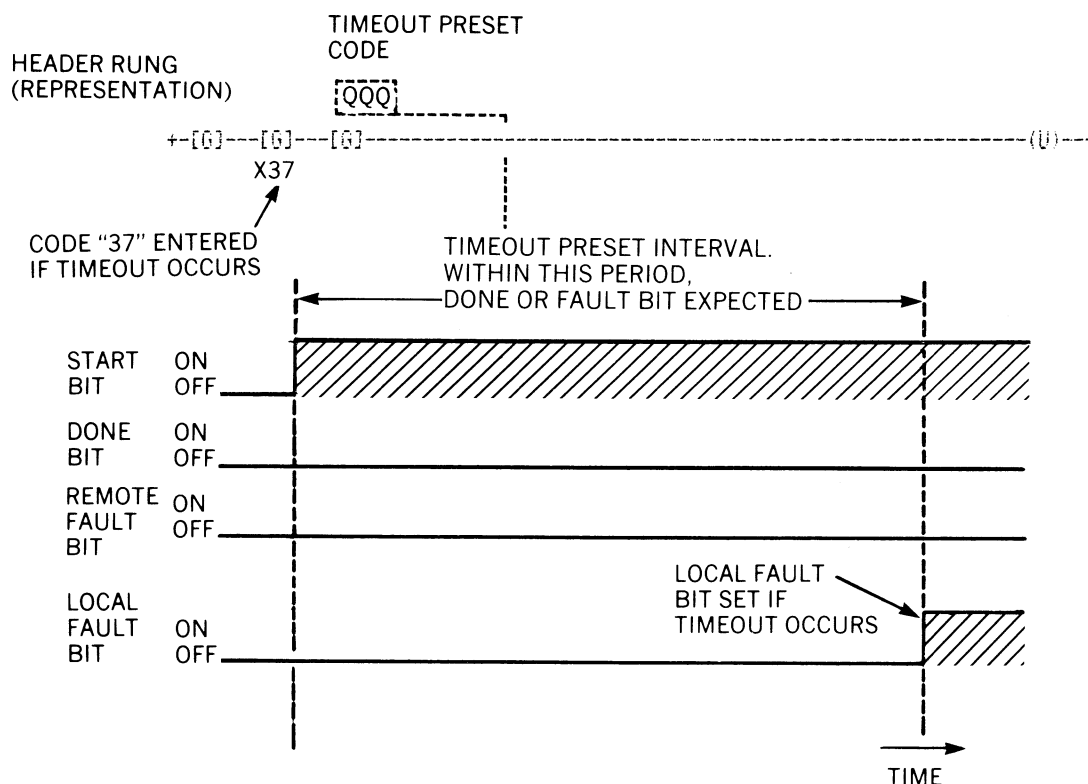
The status bits controlled by Rungs No. 1 and 2 are, in turn, used to control an OFF-DELAY timer in Rung No. 3. The OFF-DELAY timer begins to time when either of the status bits goes from OFF to ON, that is, when rung conditions go from TRUE to FALSE. Bit 23015, the Timed bit of the timer, controls the output indicator. As soon as the conditions of the timer in Rung No. 3 are TRUE, this bit is set ON causing the indicator to be energized. Once ON, this bit remains ON as long as the timer is timing, that is, for at least as long as the Preset interval. In the example of Figure 7-7, this Preset is set at 2 seconds. This value is not

critical but should exceed 0.5 seconds for practical purposes.

The OFF-DELAY timer is useful in this application because it is continually reset when its rung conditions go TRUE. This means that the Timed bit, bit 23015, remains ON for as long as any FAULT bit is changing state during programmed retries. This keeps the output indicator ON until after the DONE bit indicates command completion.

Note: Using the rungs of Figure 7-7, the indicator goes ON automatically at power-up, or whenever the Mode Select Switch on the Processor is changed from the PROGRAM LOAD (or PROG) mode to any other mode. However, the indicator only remains ON initially for the Preset interval; after this time, the indicator is valid for fault conditions.

Note that Rungs No. 1 and 2 examine all 8 FAULT bits of each type. Should fewer than 8



**FIGURE 7-8—Timeout Preset Significance**

Command rungs be programmed at a station Processor, fewer bits need be examined. Then, should Command rungs be added subsequently, the appropriate bits could be addressed in Rungs No. 1 and 2. Conversely, if more than 8 Command rungs were programmed at a station, additional rungs would be needed to examine both REMOTE and LOCAL FAULT bits for the additional commands. Status bits controlled by these additional rungs could then be examined in branches of Rung No. 3, parallel to those shown.

Of course, other methods can be used to monitor REMOTE and LOCAL FAULT bits. Such factors as availability of output terminals, memory space, and type of application dictate the specifics of FAULT bit monitoring and program response.

The use of FAULT bits in start-up and troubleshooting procedures is described in Section 9.

## 7.4 TIMEOUT PRESET VALUE

In addition to its REMOTE/LOCAL FAULT bit control, the Communication Adapter Module also provides an automatic timer for monitoring command completion. While it functions automatically during Module operation, this timer uses a Preset value entered in the user program. This feature enables the Module to monitor command execution time without using Timer (TON) instructions in the user program.

Figure 7-8 shows the significance of the Timeout Preset interval. From the time the START bit is set ON, the Communication Adapter Module must set either a DONE bit or a REMOTE or LOCAL FAULT bit within the Timeout Preset interval. Should the Module detect no DONE or FAULT bit response within the Preset interval, some type of fault is assumed. As a response to this type of timeout situation, the Communication Adapter Module

sets the LOCAL FAULT bit ON and enters the value "37" in the lower byte of the ERROR CODE storage word of the Header rung.

Timeout Preset monitoring is intended as a **backup** to the other communication monitoring functions of the Module. It is designed to signal any condition where the Module has not completed communication with another station or detected some fault condition within a short time. Because this timer is primarily intended as a backup for some LOCAL FAULT type of situation, its Preset value is not critical. In the examples of this Publication, a nominal value of 5 seconds, coded 034, is programmed as the Timeout Preset value. This value is appropriate for most applications.

#### 7.4.1 Programming the Preset Code

The Timeout Preset code for Data Highway communication is entered in the Header rung of the Communication Zone of program. The address field of the third GET instruction in this rung is used for the Timeout Preset code. Figure 7-8 shows the position of this rung element.

The 3-digit address of a GET instruction is an octal (base 8) number. Because only octal values can be entered in this address field the Timeout Preset value is a code, computed as outlined in this paragraph.

As Paragraph 7.4 pointed out, the Timeout Preset is not a critical value. For most applications, a 5-second Preset is acceptable. The code for this Timeout Preset is 034. (This code is used in all Header rungs shown in this Publication.) However, there may be instances where another Timeout Preset interval is desired. Table 7-2 lists the 3-digit codes for intervals from 1 to 10 seconds.

If it is necessary to use some value other than those provided in Table 7-2, compute the 3-digit Timeout Preset code as follows:

**Step 1** — Select a Timeout Preset interval. This interval must be larger than  $\frac{1}{2}$  second. Fractions are permitted in increments of  $\frac{1}{4}$  second. For the purpose of computing the code, label this number "S".

EXAMPLE: desired interval =  $7\frac{1}{2}$  sec = S

**Step 2** — Compute a decimal (base 10) number using the desired interval of Step 1 in the following formula:

$$4(S)+8$$

EXAMPLE:  $4(7\frac{1}{2}) + 8 = 38$

**Step 3** — Convert this value to a 3-digit octal (base 8) value.

EXAMPLE:  $38_{10} = 046_8$

For a brief description of decimal-to-octal conversion, refer to Section 13 of Publication 1772-821, Programming and Operations Manual, Mini-PLC-2 Programmable Controller.

TABLE 7-2—Timeout Preset Codes

| TIMEOUT INTERVAL (SEC.) | CODE |
|-------------------------|------|
| 1                       | 014  |
| 2                       | 020  |
| 3                       | 024  |
| 4                       | 030  |
| 5                       | 034  |
| 6                       | 040  |
| 7                       | 044  |
| 8                       | 050  |
| 9                       | 054  |
| 10                      | 060  |

#### 7.4.2 User-Programmed Timeout (Optional)

The automatic timeout of the Communication Adapter Module has a backup function. This automatic monitoring routine continuously checks Module interaction with **other** Data Highway stations, timing the execution of commands. This automatic timeout does not check Module communication with its **own** station Processor. For a backup check on Module/Processor communication, an optional pro-

grammed ON-DELAY Timer instruction (TON) may be used.

With proper Module/Processor communication, the Communication Adapter Module sets either a DONE bit or a REMOTE or LOCAL FAULT bit as a response to a command. However, in the event of faulted Module/Processor communication or faulted Module operation, a response bit might not be set. Instead, the START bit would remain ON in this instance until the fault situation was corrected. Several programming methods can be used to detect such a condition; the simplest of these methods uses an ON-DELAY Timer. Figure 7-9 shows typical rungs that can be programmed for this purpose.

In the first rung of this Figure, timer 260 times the interval between the setting of the START bit for a command and the DONE, LOCAL FAULT, or REMOTE FAULT response of the Module. If no response is received within the Preset interval of this timer, here 10 seconds, a fault may be indicated and bit 26015 set ON. The second rung examines this bit to turn ON a warning indicator. Depending on the individual application, this bit could also be used to enable or disable various parts of the program.

The Preset value of this programmed TON instruction is not critical. For this type of backup monitoring, the programmed Preset must exceed the Timeout Preset interval en-

tered as a code in the Header rung. (Remember that the automatic timeout of the Module gives a LOCAL FAULT response to a command, which would indicate normal Module/Processor communication, but faulted communication with some other station.)

As with automatic Timeout Preset monitoring, a user-programmed timeout is useful as a **backup** to the other monitoring functions of the Communication Adapter Module. (REMOTE and LOCAL FAULT bits at other stations indicate the same types of faults that can be detected using a user-programmed timeout.) A programmed timeout would not be necessary for each command from a station. Instead, a single command at each station can be monitored in this manner. Select a command that is sent regularly for this type of monitoring.

There may be other instances where program monitoring of commands is useful. In some cases, a user-programmed timeout may be used to monitor the execution time of critical commands. An application may require that a critical message, such as a Priority command, be sent within a certain limited amount of time. A programmed TON instruction can be used for this purpose; here, however, its Preset interval will generally be shorter than the interval entered as the Timeout Preset for the Module.

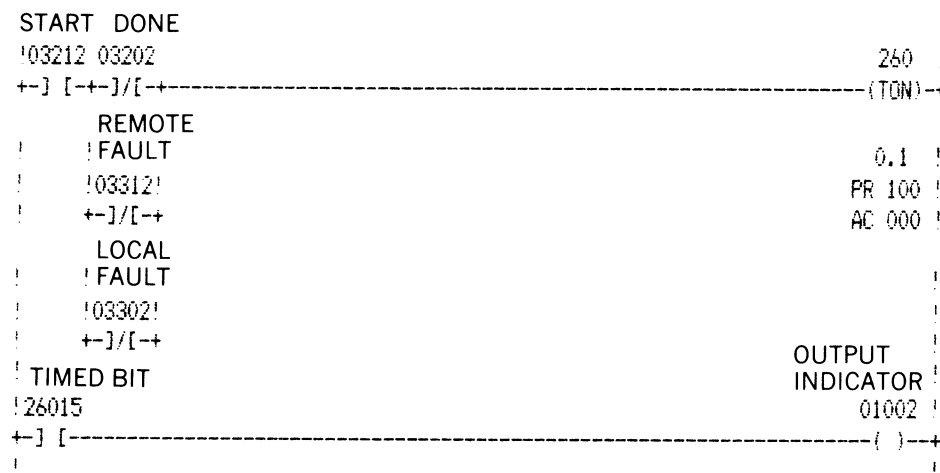


FIGURE 7-9 — Typical User-Programmed Timeout

## Section 8 STATION INTERFACING

### 8.0 GENERAL

To execute commands, the Communication Adapter Module at one station interacts with all other station interface Modules, both Communication Adapter and Communication Controller Modules, on the Data Highway. This Section describes this interaction of station interface Modules.

Because much of this interaction is transparent to user programming, the information given here is largely background information. However, an understanding of station interaction is useful in optimizing use of each individual Communication Adapter Module and of the Data Highway as a whole. Specifically, this information aids in an understanding of the following:

- Floating Master operation and polling
- Message types
- Sequence of messages for command execution
- Acknowledgments
- Retries of transmitted messages
- Priority command designation
- Automatic disconnection of faulted master station
- Commands which can be sent by computer.

### 8.1 FLOATING MASTER

Central to the interaction of station interface Modules is the concept of shared mastership — the Floating Master. With this arrangement, no single station controls the Data Highway communication link at all times. Instead, each station vies for mastership based on its need to send messages.

The advantage of this arrangement is that Data Highway operation can continue even if one or more stations is unable to maintain communication. Thus, disconnection of a station or a fault at a station Processor or Communication

Adapter Module does not disable communication between other operating stations. This minimizes the need for redundancy in many applications.

#### 8.1.1 Mastership

The Data Highway Cable links as many as 64 stations. Because this Cable has a single pair of wires, only one station can transmit at a time. When a station interface Module gains control of this data link to transmit messages, that station has mastership.

When one station interface Module is master, all other station interface Modules assume a “slave” or receive mode. This enables these stations to receive and acknowledge messages sent to them. The relationship between the master station interface Module and all other stations is shown in Figure 8-1.

As master, a Communication Adapter Module can send the following types of messages:

- Command
- Reply
- Polling

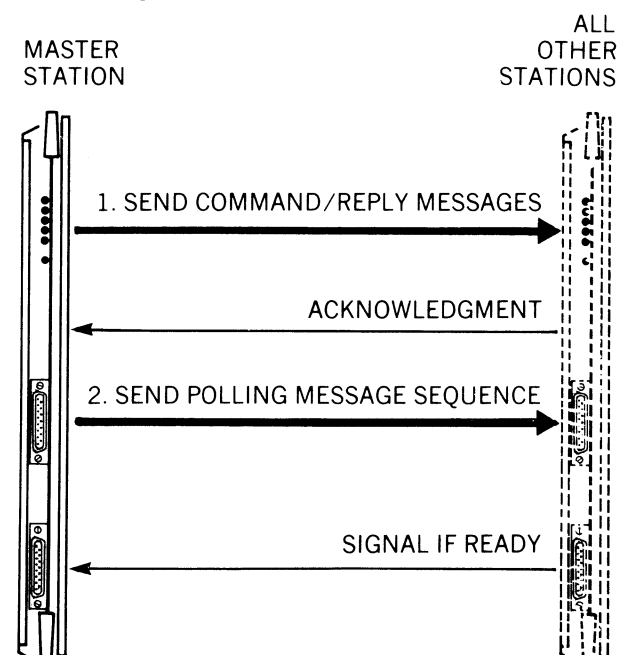


FIGURE 8-1—Master Station Functions



As described in preceding Sections, the function of both command and reply messages is the transfer of data between stations. As soon as the Communication Adapter Module attains mastership, it sends all command and reply messages which it had stored.

After the Module sends its command and reply messages, it transmits a sequence of polling messages. By this sequence, the Module selects the next station to be master of the Data Highway communication link.

### 8.1.2 Command Messages

A command message from the master Communication Adapter Module instructs another station interface Module to execute a command. In general, a command from a Communication Adapter Module can do one of the following:

- Write Data Table data to another station
- Write bit status to another station
- Request Data Table data from another station through a Read command

The Command rung, entered in the Communication Zone of user program, instructs the Communication Adapter Module to format a command message. Once this message is sent, execution of the command begins. (Command types, execution, and programming are described in Sections 4 through 7.)

Each command message causes a reply message to be generated by the receiving station.

### 8.1.3 Reply Messages

Reply messages are generated by a station in response to command messages which it receives. The reply message indicates that the command message was received and that the station interface Module has completed the sequence of events required of it for command execution. For commands that write data, the reply message indicates that the write operation has been completed at the receiving station. For commands that read data the reply message contains the data specified by the command.

The reply message is an automatic function of

Communication Adapter Module operation, transparent to the user program. In order to send a reply message, a station must have mastership.

### 8.1.4 Acknowledgment

When a station receives a message addressed to it, whether it is a command or reply message, the receiving station sends an acknowledgment. The acknowledgment is merely a signal which confirms that a message has been received. Transparent to the user program, the acknowledgment is an automatic function of Communication Adapter Module operation.

The acknowledgment serves 2 basic functions: it indicates that the receiving station is operating and has received the message and it indicates that the received command or reply message is in intelligible format. Should the proper acknowledgment not be received, a fault in the receiving Module may be indicated. In this event, the master station Communication Adapter Module retries transmission of the message. The Communication Adapter Module attempts 8 retries for a command or reply message. Retries are automatic, transparent to the user program.

If retries are unsuccessful, a LOCAL FAULT bit may be set ON at the local (sending) station Processor. (LOCAL FAULT bits are described in Section 6.)

Acknowledgments are only sent by a station which is in the receive mode, not the current master station.

### 8.1.5 Message Priority

Each message transmitted over the Data Highway communication link has one of these priority levels:

- Normal
- Priority

These priority levels determine the order in which stations obtain mastership and the order in which messages are transmitted. Priority messages of a given type (either command, reply, or polling) will always be transmitted before normal messages of the same type.

The programmer designates a priority level for each command message. The Command Code, an element in each Command rung, specifies the priority level of the command message. The station which receives a command message automatically establishes the same priority level for its corresponding reply message. (The Command Code is described in Section 5.)

NOTE: Priority commands are executed ahead of normal commands throughout the command/reply message cycle. For this reason, a command should be given Priority designation **only** when special handling of specific data is required. Using an excessive number of Priority commands defeats the purpose of this feature and could delay or inhibit the transmission of normal messages.

When a station Communication Adapter Module has a Priority command or reply message ready for transmission, the Module responds to the next Priority poll in order to gain mastership.

### 8.1.6 Polling

No single station is permanent master of the Data Highway communication link. Each station vies for mastership when it needs to send a message. The station interface Module at the current master station conducts a poll to select the next master station. A poll is an orderly, systematic method to determine which stations have messages to send and to select one of these stations as master.

Polling protocol is carried out as an automatic function of station Communication Adapter and Communication Controller Modules. As such, the polling scheme is transparent to user programming. An understanding of polling, however, is useful to optimize use of the Data Highway communication link. Such programmer considerations as designation of Priority commands and Station Nos. are related to the polling scheme. In addition, a knowledge of polling mechanics helps to understand the sequencing of messages between Data Highway stations.

As Figure 8-1 shows, once the master station has sent all of its messages, its next function is

to poll all other stations. There are 2 polling sequences conducted by the master station, in this order:

- Priority poll
- Normal poll (if no response to Priority polling is received)

Polling addresses a group of stations at a time. The size of the polled group is always a power of 2: 1, 2, 4, 8, 16, 32, 64. With each step in polling procedure, the group size is either half (descending binary) or double (ascending binary) the group size polled in the previous step.

A polling message is sent to this group of stations by the current master station interface Module. From the group of polled stations, any station which is ready to attain mastership and transmit a message sends a brief response signal after receiving the polling message.

The following Paragraphs describe the polling sequences conducted by the master station.

#### PRIORITY POLL

The first polling sequence executed by the master station Communication Adapter Module is a Priority poll. The purpose of the Priority poll is to identify a station which is ready to transmit a Priority command or reply message. Mastership can then be transferred to this station.

The first Priority polling message addresses all Station Nos. Any station Communication Adapter Module with a Priority command or reply message ready for transmission signals a response to this poll.

If a response signal is received to this first Priority poll, the master (polling) station continues polling to locate a responding station. In this polling sequence, the master station uses a descending binary search, which reduces the size of the polled group by half with each step until a responding station is located.

If no station responds to the first Priority poll, the master station then conducts a normal poll.

### **NORMAL POLL**

When no response to the first Priority poll is received, the master (polling) station conducts a normal poll. Its purpose is to identify a station which is ready to transmit a normal command or reply message. Mastership can then be transferred to this station.

The normal poll uses a combination of ascending and descending binary search methods. In its first step, only the next highest Station No. is polled. If it responds, mastership is transferred directly to this station.

If the next highest Station No. is polled and does not respond, the normal poll continues, using an ascending binary search. With this method, the next 2 Station Nos. are polled, then the next 4, then the next 8 — doubling group size with each step until all Station Nos. have been polled.

Should the master station receive a response to any of these subsequent polls, it must then narrow down the group size to locate the responding station. To do this, it performs a descending binary search, dividing the polled group in half with each step, to locate a responding station.

Should no response to normal polling be received, the station interface Module continues polling, addressing all Station Nos. with polling messages until a station with any message ready to transmit responds.

Note that the normal poll gives preference to the next highest Station No. in succession. As a result, when stations are numbered in succession, fewer steps are needed to transfer mastership in normal polling. For this reason, it is recommended that the programmer assign Station Nos. in succession. (The actual physical locations of stations are not important in assigning Station Nos., as long as a consecutive block of Station Nos. is used and numbers are not skipped.)

### **8.2 LINK DISCONNECT**

Floating Master operation continues normally as long as all stations share mastership of the communication link. However, if any one station retained continuous control of the com-

munication link due to a fault condition, Floating Master operation would not be possible and Data Highway communication would be disabled. As a preventive measure against this type of situation, each station interface Module has link disconnect circuitry.

Communication Adapter Module transmitting and receiving circuitry connect to the Data Highway communication link through a reed relay. As long as the reed relay contacts are closed, the Module is connected to the communication link. When these contacts are opened, the Module is disconnected from the link.

Control of this reed relay itself is the function of that part of Module circuitry which monitors Module behavior. If a faulted condition is sensed by the Module, the reed relay coil is de-energized and the relay contacts opened, disconnecting the Module from the Data Highway communication link.

A LOCAL FAULT bit may be examined in the user program to detect this disconnection of a station. (Refer to Section 6.)

### **8.3 COMMANDS FROM A COMPUTER**

The Communication Adapter Module can execute commands from a computer connected through a Communication Controller Module (Cat.No. 1771-KC or -KD). The command set of the computer includes the command set of the Communication Adapter Module:

- Protected Write
- Protected Bit Write
- Unprotected Read
- Unprotected Write
- Unprotected Bit Write

These commands have the same execution sequence and memory access as the same commands from a Communication Adapter Module.

In addition to these commands, the command set from the computer includes the following:

- Privileged Read
- Privileged Write

- Diagnostic Loop
- Diagnostic Read
- Diagnostic Counters Reset
- Diagnostic Status
- Output Control (PLC Controllers only)

Privileged commands give the computer the capability to read from or write into the entire Processor memory. This includes both Data Table and User Program areas. Privileged commands are used chiefly to load programs from a computer to a station Processor on the Data Highway.

During program downloading, outputs can be held in their last state by the Processor or disabled by a Module switch setting, as described in paragraph 3.1.3. However, at programmer's option, Privileged Write commands can also be used to change Data Table values during a download of program. (Refer to Publication 1771-802.)

Diagnostic commands affect only the Communication Adapter Module at a station, not the station Processor. These commands access the read/write memory of the Communication Adapter Module. They provide a check of Module activity and permit computer control of specific aspects of Communication Adapter Module behavior. A summary of Diagnostic commands and their functions is given in Table 8-1.

### 8.3.1 Output Control Commands

There are 3 types of Output Control commands which can be sent to the Communication Adapter Module:

- Output Disable
- Program Enable
- Scan Enable

The Output Disable command is used to turn Controller outputs OFF before program downloading or other operation. The Program Enable and Scan Enable commands are used to return control of outputs to the Controller after program downloading.

The format and use of these commands is described in the User's Manual, Communication Controller Module, Publication 1771-802.

**TABLE 8-1 — Diagnostic Command Summary**

| COMMAND                   | FUNCTION                                                            |
|---------------------------|---------------------------------------------------------------------|
| Diagnostic Loop           | Echoes transmitted data back in reply message                       |
| Diagnostic Read           | Copies up to 245 bytes of data from Module memory                   |
| Diagnostic Counters Reset | Resets all diagnostic error counters on the Module                  |
| Diagnostic Status         | Allows access to a block of Processor and Module status information |

## Section 9 START-UP AND TROUBLESHOOTING

### 9.0 GENERAL

This Section outlines an approach to start-up and troubleshooting procedures. Necessarily, exact procedures that would be followed vary from one application to the next. However, these guidelines provide a useful starting point when starting up a Data Highway installation or when trying to locate a fault condition.

The methods described in this Section can be used to test any station which contains a Bulletin 1774 PLC Programmable Controller and a Communication Adapter Module (Cat. No. 1774-KA). Methods for start-up and troubleshooting of a Bulletin 1772 PLC-2/20, PLC-2 or Mini-PLC-2 Controller using a Communication Adapter Module (Cat. No. 1771-KA) are described in Publication 1771-801.

When using a computer connected through a Communication Controller Module, additional procedures are available for start-up and troubleshooting. Among these added capabilities, a set of Diagnostic commands is available. Use of these commands to test Module interaction is described in the User's Manual, Communication Controller Module, Publication 1771-802. Even where a computer is connected to the Data Highway, however, it is recommended that the procedures of this Section be followed for initial testing of the station. Once each station containing a Programmable Controller has been tested, operation of the computer interfacing can then be checked.

### 9.1 START-UP AND TROUBLESHOOTING AIDS

This Paragraph describes the tools which are available for start-up and troubleshooting personnel. These aids are provided by the Module itself, by programming terminals, and by careful documentation provided by the programmer of the station Processor.

#### 9.1.1 Module Indicators

Module diagnostic indicators show the status of Module operation with its station Processor

and with the Data Highway. This paragraph describes these indicators and their significance in start-up and troubleshooting.

Figure 9-1 shows the significance of various combinations of energized indicators. Note that the 4 green indicators show Module status in normal message transfer. The 2 red indicators show the status of Module tests of the program and Module communication with its station Processor.

The following paragraphs describe each indicator and its significance to the troubleshooter.

#### TX

The Transmitting indicator, labeled TX, turns ON when the Module is current master of the Data Highway. As described in Section 8, mastership means that the Module is sending messages on the Data Highway communication link. This may be a command, reply, or polling message.

#### RX

The Receiving indicator, labeled RX, turns ON when the Module is receiving a message addressed to it. When both this indicator and the TX indicator are ON, the Module is polling.

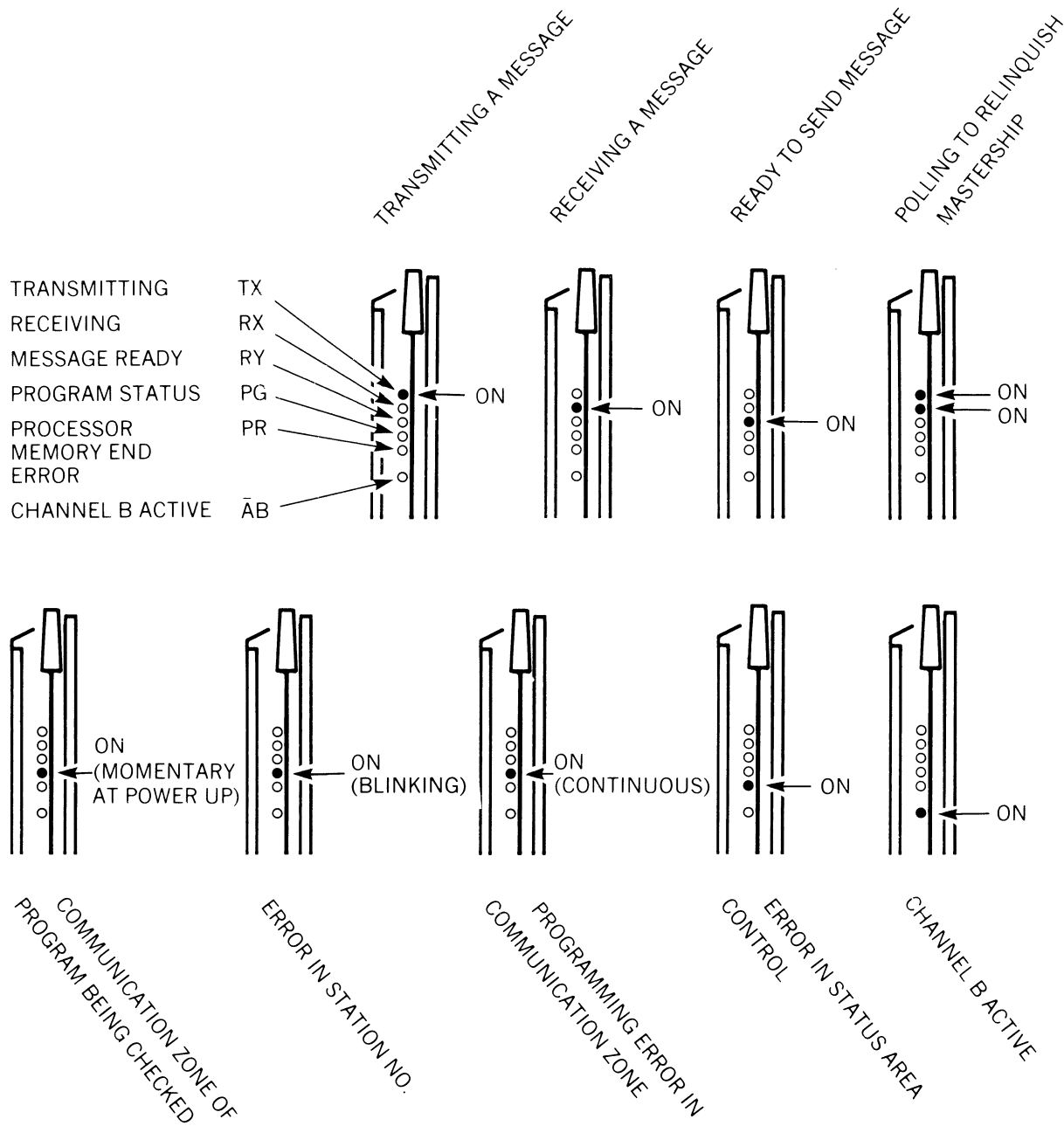
#### RY

The Message Ready indicator, labeled RY, turns ON when the Module has messages which it is ready to transmit. With this indicator ON, the Module is ready to assume mastership when it is polled.

#### PG

The Program Status indicator, labeled PG, indicates the status of module checks on the Communication Zone rungs of program. (These rungs are described in Section 5.)

The Module checks the Communication Zone rungs of program at power-up and whenever the Mode Select Switch on the Processor is turned from PROGRAM to TEST-MONITOR,



**FIGURE 9-1 — Module Indicator Combinations**

RUN-MONITOR, or RUN/PROGRAM LOAD position. During this initializing procedure, the PG indicator turns ON. After the Module has checked these Communication Zone rungs, and if it has found no errors in programming format for these rungs, the Module turns the PG indicator OFF. However, should any programming error be detected in the Communication Zone of program this indicator remains ON and Module activity on the Data Highway is disabled. In this event, the ERROR CODE stor-

age word can be checked for an indication of the problem. (Refer to Paragraph 9.2 for start-up procedures.)

#### PR

The Processor Memory End Error indicator, labeled PR, shows the status of Module interaction with other optional Processor Modules. Specifically, this Module interaction refers to control of the 9-word Status Area at the end of

Processor memory. (The Status Area is described in paragraph 2.2.1.)

When normal Status Area control is detected by the Module, this indicator is OFF. When the PR indicator is ON, an error in Status Area control has been detected. The significance of this indicator depends upon whether it turns ON immediately after power-up or at some later time, as follows:

- **ON at power-up** — Should the PR indicator turn ON at power-up, assume that program instructions or Data Files or Messages extend into the last 9 words of Processor memory. This may mean that a switch setting is needed to inhibit the Status Area control function of the Module. (Refer to Case 2 in paragraph 2.2.1.)
- **ON subsequent to power-up** — Should the PR indicator turn ON at some time subsequent to power-up, a discrepancy in data stored in the 9-word Status Area has been detected. In this event, clear this Status Area by loading 0's into the last 9 words of PLC Processor memory. This can be accomplished through Privileged Write commands from a computer or by a partial clearing of memory using a Program Panel or Industrial Terminal.

Whenever this type of memory error is detected and the PR indicator is ON, the outputs of the station PLC Programmable Controller may be turned OFF. In addition to this, Module execution of commands at its station Processor may be disabled. If this should occur, make the necessary Module switch settings or program changes for proper Status Area control, as described in paragraphs 2.2.1 and 3.1.5.

Follow the procedures of paragraph 9.3.2 for Module removal.

## **AB**

The Channel B Active indicator, labeled **AB**, turns ON only if the Channel B socket on the front of the Module is active and communicating on the Data Highway. (The Channel B socket is the lower socket on the front of the Module.) Normally, the Channel A socket is used and this indicator is OFF. However, should the Data Highway Cable be connected to the

Channel B socket (and not to the Channel A socket) and the Channel B socket be active, this indicator illuminates.

## **9.1.2 Programming Terminals**

The Industrial Terminal and Program Panel are invaluable aids for start-up and troubleshooting. These devices make available such aids as status indicators, value display, bit ON/OFF status control, FAULT bit monitoring, and ERROR CODE display.

For the initial start-up procedures described in this Section, it is best to have at least 2 programming terminals available. This allows both a sending and a receiving station to be monitored at the same time.

The operation and use of the various programming terminals are described in other Publications. (Refer to Section 1.) This paragraph briefly reviews the following functions of the programming terminals which have a special importance in troubleshooting testing:

- SEARCH functions
- Status indication
- Bit Monitoring

Each of these tools is used in the procedures of Paragraphs 9.2 and 9.3.

### SEARCH FUNCTIONS

The SEARCH functions enable the various parts of the program to be quickly located and displayed. Table 9-1 lists the SEARCH functions for the PLC Program Panel. Table 9-2 lists the SEARCH functions available using the Industrial Terminal.

### STATUS INDICATION

The programming terminals provide a status indication for most program instructions. For both the Industrial Terminal and the PLC Program Panel (CRT), this status indication is similar. With these terminals, an instruction symbol is intensified when the instruction is logically TRUE. For an input instruction, this means that the condition specified by the instruction has been met. For an output instruction, this means that the instruction is being carried out.

**TABLE 9-1 — SEARCH Functions — PLC Program Panels**

| PROGRAM<br>PANEL<br>KEYHEAD                                                                                                                                                                                                                                                                                                                      | RESPONSE                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <br><br><br> | <p>Positions cursor on following program instruction.</p> <p>Positions cursor on preceding program instruction.</p> <p>When cursor is on the first rung instruction, this function causes the preceding rung to be displayed. When cursor is on some rung instruction other than the first, this function causes the cursor to be positioned on the first rung instruction.</p> <p>Positions cursor on the next output instruction. When the cursor already points to an output instruction, displays the following program rung.</p> |
| SEARCH 01000                                                                                                                                                                                                                                                                                                                                     | Displays the first program rung for 256-word Data Table (Using Cat. No. 1774-TB Program Panel Interface Module)                                                                                                                                                                                                                                                                                                                                                                                                                       |
| SEARCH 02000                                                                                                                                                                                                                                                                                                                                     | Displays the first program rung for 512-word Data Table (Using Cat. No. 1774-TB Program Panel Interface Module when also using Processor Module No. 1 of Cat. No. 1774-LB, Series B or later)                                                                                                                                                                                                                                                                                                                                         |
| SEARCH                                                                                                                                                                                                                                                          | Displays the first program rung (for Cat. No. 1774-TB2 Program Panel Interface Modules)                                                                                                                                                                                                                                                                                                                                                                                                                                               |
| SEARCH 37717                                                                                                                                                                                                                                                    | Displays the END of program statement                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
| SEARCH                                                                                                                                                                                                                                                        | Displays the END of program statement (for Cat. No. 1774-TB2 Program Panel Interface Modules)                                                                                                                                                                                                                                                                                                                                                                                                                                         |
| SEARCH A XXXXX<br>SEARCH B XXX                                                                                                                                                                                                                                                                                                                   | The specified Instruction is displayed as it appears in one location in the program. Press [SEARCH] to display other locations where this Instruction is used.                                                                                                                                                                                                                                                                                                                                                                        |
| SEARCH 8 XXX                                                                                                                                                                                                                                                                                                                                     | Displays output Instructions which control the word XXX or any of its 16-bits. <sup>1</sup> After the key sequence shown has been pressed, simply press [SEARCH] to display each other location in the program in which word XXX or its individual bits are addressed.                                                                                                                                                                                                                                                                |
| <b>LEGEND</b><br><br>A<br><br>B<br><br>X                                                                                                                                                                                                                                                                                                         | <p>— A relay-type instruction which addresses a single bit. This includes EXAMINE ON, EXAMINE OFF, OUTPUT ENERGIZE, OUTPUT DE-ENERGIZE, LATCH and UNLATCH instruction.</p> <p>— An instruction which addresses a 3-digit word. This includes all Timer/Counter, GET/PUT, LES, EQU, and Arithmetic Instructions.</p> <p>— Numeric key.</p>                                                                                                                                                                                             |
| <p><sup>1</sup> Instructions for which the word address can be searched include the following: all Timer/Counter, OUTPUT ENERGIZE, LATCH and UNLATCH, GET, PUT, LES, EQU, and Arithmetic instructions. This function does not display EXAMINE Instructions which address individual bits of the word.</p>                                        |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |



**TABLE 9-2 — SEARCH Functions — Industrial Terminal**

| INDUSTRIAL<br>TERMINAL<br>KEY<br>SEQUENCE                                                                                                                                                                                                                                                                                                        | RESPONSE                                                                                                                                                                                                                                                                                                      |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <br><br><br> | <p>Positions cursor on following program instruction.</p> <p>Positions cursor on preceding program instruction.</p> <p>Displays previous rung.</p> <p>Displays following rung.</p>                                                                                                                            |
| SEARCH 01000                                                                                                                                                                                                                                                                                                                                     | Displays the first program rung for 256-word Data Table (Using Cat. No. 1774-TB Program Panel Interface Module)                                                                                                                                                                                               |
| SEARCH 02000                                                                                                                                                                                                                                                                                                                                     | Displays the first program rung for 512-word Data Table (Using Cat. No. 1774-TB Program Panel Interface Module when also using Processor Module No. 1 of Cat. No. 1774-LB, Series B or later)                                                                                                                 |
| SEARCH                                                                                                                                                                                                                                                          | Displays first rung of program (using Cat. No. 1774-TB2 Program Panel Interface Module)                                                                                                                                                                                                                       |
| SEARCH 37717                                                                                                                                                                                                                                                  | Displays the END of program statement                                                                                                                                                                                                                                                                         |
| SEARCH                                                                                                                                                                                                                                                        | Displays END of program statement (using Cat. No. 1774-TB2 Program Panel Interface Module)                                                                                                                                                                                                                    |
| SEARCH-DISPLAY                                                                                                                                                                                                                                                                                                                                   | Single rung display. (Press same key sequence to restore multiple rung display.)                                                                                                                                                                                                                              |
| SEARCH A XXXXX<br>SEARCH B XXX                                                                                                                                                                                                                                                                                                                   | The specified instruction is displayed as it appears in one location in the program. Press [SEARCH] to display other locations where this instruction is used.                                                                                                                                                |
| SEARCH 8 XXX                                                                                                                                                                                                                                                                                                                                     | Displays output instructions which control the word XXX or any of its 16 bits. After initially pressing this key sequence, simply press [SEARCH] to display each other program location in which word XXX or its individual bits are addressed. (EXAMINE instructions not displayed by this SEARCH function.) |
| <b>LEGEND</b>                                                                                                                                                                                                                                                                                                                                    |                                                                                                                                                                                                                                                                                                               |
| A                                                                                                                                                                                                                                                                                                                                                | A relay-type instruction which addresses a single bit. This includes EXAMINE ON, EXAMINE OFF, OUTPUT ENERGIZE, OUTPUT DE-ENERGIZE, LATCH, and UNLATCH instructions.                                                                                                                                           |
| B                                                                                                                                                                                                                                                                                                                                                | An instruction which addresses a 3-digit word. This includes all Timer/Counter, GET/PUT, LES, EQU, and Arithmetic instructions.                                                                                                                                                                               |
| X                                                                                                                                                                                                                                                                                                                                                | Numeric key.                                                                                                                                                                                                                                                                                                  |

An EXAMINE ON instruction, for example, is intensified when the corresponding input device is ON. This means that the memory bit addressed by the instruction is ON. Conversely, an EXAMINE OFF instruction is intensified when the memory bit it addresses is OFF.

Note that this status indication is provided in RUN-MONITOR, RUN/PROGRAM LOAD and TEST-MONITOR modes. In the PROGRAM LOAD (or PROG) mode, however, intensity of a displayed instruction indicates cursor position.

Figure 9-2 illustrates the significance of an intensified instruction for both the Industrial Terminal and the PLC Program Panel.

The status indication is useful in monitoring the ON/OFF status of START/DONE and REMOTE/LOCAL FAULT bits.

### **BIT MONITORING**

When using a Program Panel Interface Module with Cat. No. 1774-TB2 of Series B or later, the

Bit Monitoring feature can be used for start-up and troubleshooting monitoring and testing. This feature allows the display of any bit in the Data Table, showing its ON/OFF status.

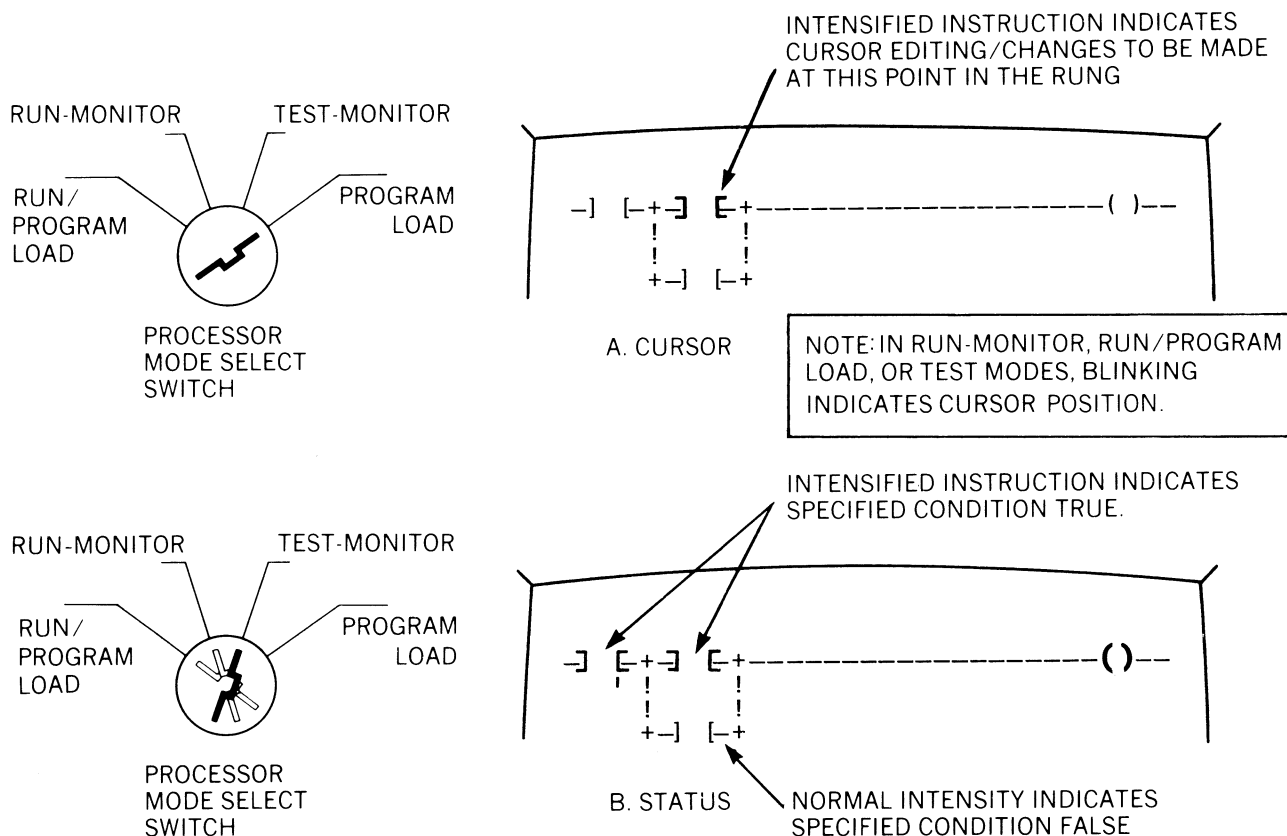
To monitor the bits of any Data Table word, press the following key sequence:

[SEARCH] [5] [3]

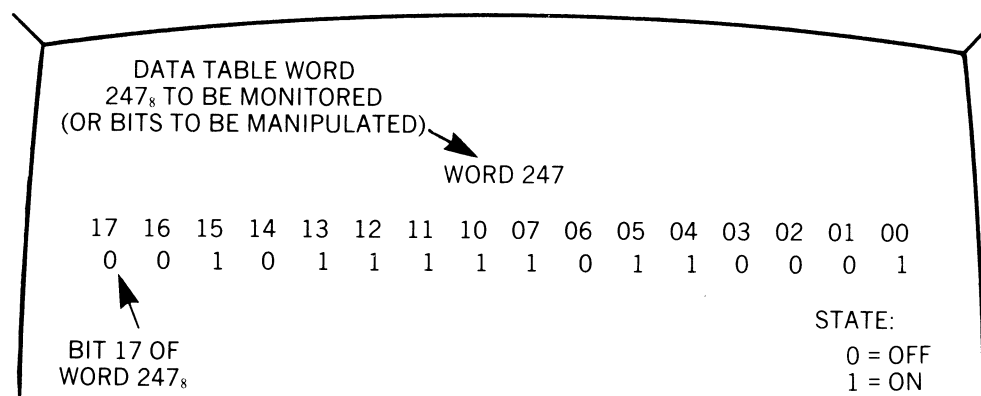
Then enter the address digits of the word to be displayed.

This technique, performed with the Processor Mode Select Switch in any position, causes all 16 bits of an individual word to be displayed on the Industrial Terminal or Program Panel. Figure 9-3 shows the Bit Monitoring display as it might appear for Data Table word 247.

As this Figure shows, the status of each bit in the display is shown as a 1 or 0, underneath the number of the bit. The bit numbers are arranged so that bit 17 is furthest left, bit 00 furthest right. A "1" represents "ON" or energized; a "0" represents "OFF" or de-energized.



**FIGURE 9-2 — Meaning of Intensified CRT Display**



**FIGURE 9-3 — Bit Monitoring/Manipulation Display Format**

This can be an invaluable technique for monitoring complete START/DONE and REMOTE/LOCAL FAULT words at an individual controller.

Two programming terminal keys allow the operator to quickly display adjacent Data Table words, thereby avoiding the inconvenience of entering another 3- or 4-digit address. These keys are [RUNG ↑] and [RUNG ↓].

### 9.1.3 REMOTE/LOCAL FAULT Bits

The REMOTE and LOCAL FAULT bits provide the chief indicator of a hardware-related fault which prevents normal communication. As recommended in Section 7, these bits must be programmed to control some output device to alert plant personnel of a fault condition. When this output device signals a fault condition, a programming terminal can then be used to display the ON/OFF status of any REMOTE or LOCAL FAULT bit at the station Processor.

Paragraph 9.3 gives an example for using these bits in troubleshooting.

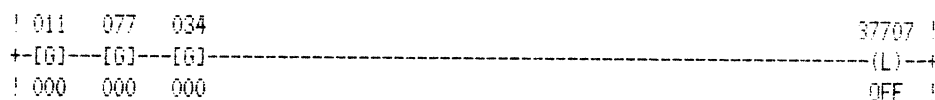
Figure 9-4 summarizes the significance of both REMOTE and LOCAL FAULT bits.

### 9.1.4 ERROR CODE Storage Word

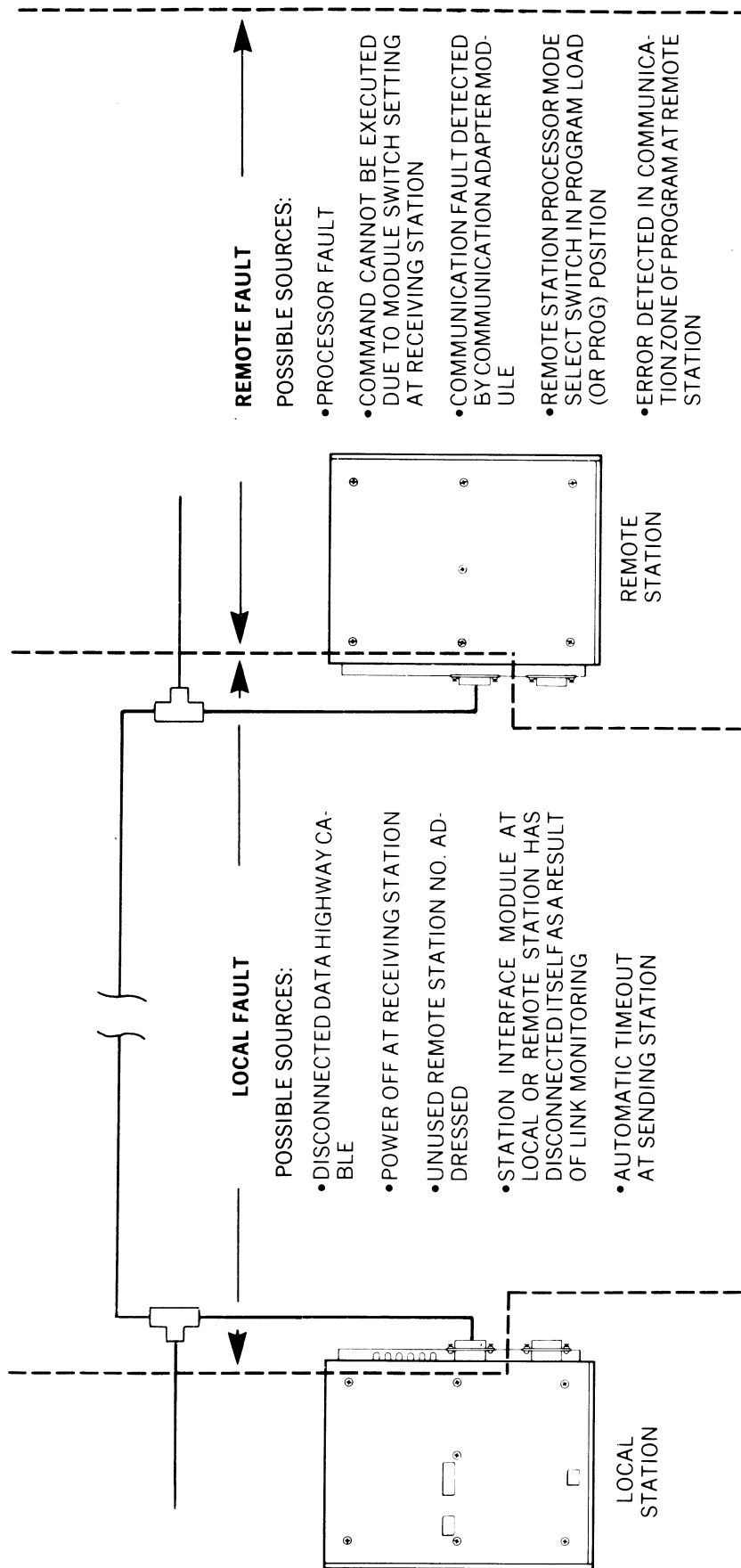
The ERROR CODE storage word is especially useful for station start-up. The codes displayed in the lower 2 digits of the ERROR CODE word may indicate an error in programming, switch setting, or certain other conditions which prevent normal Communication Adapter Module operation.

The ERROR CODE storage word is addressed by the second GET instruction in the Header rung (Refer to Figure 9-5.) This is the first rung of the Communication Zone of program.

Table 9-3 lists each ERROR CODE and its meaning.



**FIGURE 9-5 — Header Rung**



**FIGURE 9-4 — REMOTE/LOCAL FAULT Bit Significance**

**TABLE 9-3 — ERROR CODE Listing**

| <b>CODE</b>                      | <b>MEANING</b>                                                                                                         |
|----------------------------------|------------------------------------------------------------------------------------------------------------------------|
| 01,02                            | Processor communications problem. May be Processor Fault                                                               |
| 03                               | No memory in Communication Adapter Module for START bit file                                                           |
| <b>MEMORY ACCESS RUNG FORMAT</b> |                                                                                                                        |
| 04                               | First GET instruction incorrectly entered                                                                              |
| 05                               | Invalid Station No.                                                                                                    |
| 06                               | Second GET instruction incorrectly entered                                                                             |
| 07                               | Third GET instruction incorrectly entered                                                                              |
| 08                               | Third GET address less than second GET address (improper Access boundary definition)                                   |
| 09                               | Invalid end of Access branch (BRANCH END instruction must be inserted.)                                                |
| 10                               | Invalid end of Access rung                                                                                             |
| 11                               | Beginning of next rung invalid. (Refers to any rung after a Memory Access rung.) Or, BRANCH START instruction missing. |
| <b>COMMAND RUNG FORMAT</b>       |                                                                                                                        |
| 12                               | START bit in lower byte. (START bit must be selected from upper byte, bits 10-17.)                                     |
| 13                               | Second EXAMINE element incorrectly entered                                                                             |
| 14                               | Invalid Command Code                                                                                                   |
| 15                               | Invalid remote Station No. in Command Code                                                                             |
| 16                               | Invalid element in Bit Write rung                                                                                      |
| 17                               | First GET incorrectly entered (Word command format)                                                                    |
| 18                               | Second GET incorrectly entered (Word command format)                                                                   |
| 19                               | Third GET incorrectly entered (Word command format)                                                                    |
| 20                               | End of rung incorrectly entered (Word command format)                                                                  |
| 21                               | Beginning of new Command rung invalid or Memory Access rung programmed following Command rung.                         |
| 22                               | REMOTE/LOCAL FAULT word not in Data Table. (START/DONE word incorrectly chosen.)                                       |
| 23                               | Unprotected command not allowed by switch setting at local station.                                                    |
| 26                               | Excessive number of Command rungs (more than 256).                                                                     |

**TABLE 9-3 — (Continued)**

| <b>COMMUNICATIONS ERRORS<br/>(MAY BE DISPLAYED IN CONJUNCTION WITH REMOTE/LOCAL FAULT BITS)</b> |                                                                                                                                                                                                                                                                                                                                                   |
|-------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 30                                                                                              | Processor memory discrepancy                                                                                                                                                                                                                                                                                                                      |
| 31                                                                                              | Controller communications problem. May be Processor fault.                                                                                                                                                                                                                                                                                        |
| 32                                                                                              | Improper command message size                                                                                                                                                                                                                                                                                                                     |
| 33                                                                                              | Invalid Command Code                                                                                                                                                                                                                                                                                                                              |
| 34                                                                                              | Invalid Station No.                                                                                                                                                                                                                                                                                                                               |
| 35                                                                                              | Attempt to send Unprotected command invalid                                                                                                                                                                                                                                                                                                       |
| 36                                                                                              | Command execution aborted by sending station Processor                                                                                                                                                                                                                                                                                            |
| 37                                                                                              | Command execution aborted. Execution time exceeds Timeout Preset value.                                                                                                                                                                                                                                                                           |
| 50                                                                                              | Processor communications problem. May be Processor fault.                                                                                                                                                                                                                                                                                         |
| 51                                                                                              | Invalid Transparent word in reply message.                                                                                                                                                                                                                                                                                                        |
| 52                                                                                              | No Communication Zone rungs in program                                                                                                                                                                                                                                                                                                            |
| 53                                                                                              | Reply not expected. (Reply received, but START bit is OFF.)                                                                                                                                                                                                                                                                                       |
| 54                                                                                              | Processor memory not in format for communication                                                                                                                                                                                                                                                                                                  |
| 55                                                                                              | Invalid reply. (Reply received, but Communication Zone rungs are incorrectly entered. Or, reply received when Processor Mode Select keylock switch is in the PROGRAM LOAD position.) Program Status indicator (PG) may be ON to indicate this type of error condition.<br><br>May mean Memory Access rung missing for received Protected command. |
| 56                                                                                              | Incorrect sequence number in reply. (Refers to Transparent word in message format.)                                                                                                                                                                                                                                                               |
| 81                                                                                              | Illegal command                                                                                                                                                                                                                                                                                                                                   |
| 82                                                                                              | Station Processor communication problem.                                                                                                                                                                                                                                                                                                          |
| 83                                                                                              | Remote station Processor faulted or OFF.                                                                                                                                                                                                                                                                                                          |
| 84                                                                                              | I/O Fault at remote station Processor.                                                                                                                                                                                                                                                                                                            |
| 85                                                                                              | Transmitted command disallowed by switch setting or Memory Access rung programming at remote station.                                                                                                                                                                                                                                             |
| 86                                                                                              | Transmitted command disallowed by switch setting at remote station.                                                                                                                                                                                                                                                                               |
| 87                                                                                              | Remote station Processor in PROG or PROGRAM LOAD mode.                                                                                                                                                                                                                                                                                            |
| 88                                                                                              | Communication Zone invalid at remote station Processor. Program Status indicator (PROG) may be ON at that station.                                                                                                                                                                                                                                |
| 89                                                                                              | Remote station Communication Adapter Module unable to buffer received command in memory.                                                                                                                                                                                                                                                          |
| 92                                                                                              | Destination station fails to respond.                                                                                                                                                                                                                                                                                                             |
| 93                                                                                              | Contention between master stations prevents message transmission.                                                                                                                                                                                                                                                                                 |

### 9.1.5 Test Rungs (Optional)

For start-up and troubleshooting testing, the user must have some means for control of each START bit. To execute a command during testing, the user can then energize the START bit for each command using these means.

The START bit is controlled by a rung of the user application program. The most direct way to control the START bit in troubleshooting, therefore, would be to manipulate the conditions of this rung to energize the START bit. If this can be done easily for each START bit at a station Processor, the use of any special procedure for command initiation is unnecessary.

However, it may not always be practical to simulate application conditions for the purpose of command testing. In this case, a special set of test rungs may be added at the end of the user program. Using these rungs, the programmer can control command initiation directly while verifying command execution from the programming terminal.

**CAUTION:** Do not alter the application program for troubleshooting purposes. This can be a dangerous practice, since the program may no longer operate as had been intended.

The optional test rungs described here are recommended with this caution in mind. The specific format of these rungs allows control of commands without altering the main body of the application program. This format is recommended because it allows command testing only under strictly controlled conditions.

The optional test rungs are shown in Figure 9-6. Within this Conditional Ignore zone, the START bit is unconditionally LATCHED ON (Rung No. 2), then UNLATCHED when the DONE bit comes ON (Rung No. 3). In Rung No. 1, a single input device, 11100, is the condition which enables execution of instructions within the zone.

This input device should be some type of normally-open input switch that is readily

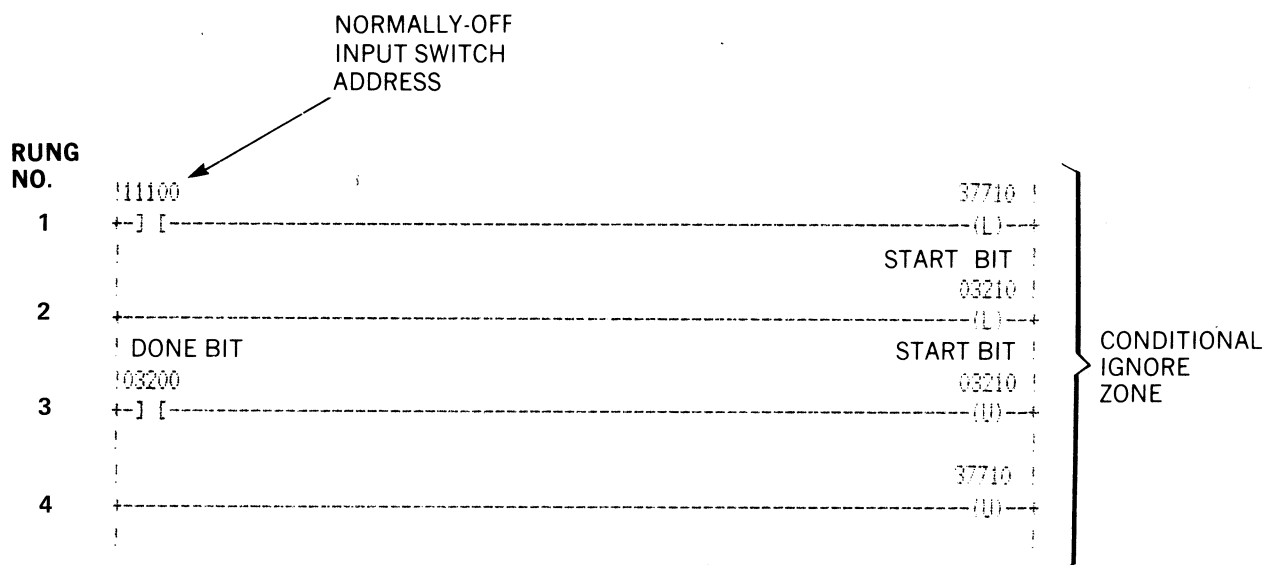


FIGURE 9-6 — Optional Test Rungs

accessible for test purposes. This switch can be installed for the sole purpose of command testing. (If this is the case, then the set of optional test rungs can be kept at the end of the user program after start-up procedures are completed.) Or, this can be a switch which might normally serve some other purpose in the application, such as an operator push button or other switch. (If this is the case, the set of optional test rungs must be removed after start-up procedures are completed.) To test individual commands, the addresses of the corresponding START and DONE bits are entered into Rungs No. 2 and 3. In this manner, each command can be tested individually.

These rungs send the command continuously, as long as the Conditional Ignore zone is enabled. As a quick check of this continuous command execution and completion, another rung can be added to the test rungs within the zone. This rung examines the START bit as the input condition to a counter, as shown in Figure 9-7. Using this optional counter, the user can verify that the command is being executed continuously. To use this optional counter, insert this additional rung within the Conditional Ignore zone, between Rungs No. 3 and 4.

Note that the counter value shown on the programming terminal may not display the actual number of times a command has been sent, due to CRT delay time. However, the purpose of the counter is to provide an indication to the troubleshooter that the command is being continuously executed, rather than to give an actual count of the number of times it is executed.

Again, the use of these test rungs is optional, subject to the discretion of the programmer.

An advantage in using these rungs is that, if an input switch is installed for the purpose of command testing only, the rungs may be kept at the end of the user program after start-up is completed. This enables the use of these rungs in subsequent troubleshooting or later testing, as when a Command rung is subsequently added to the Communication Zone of program. Of course, these rungs can be removed after start-up is completed, at the programmer's option.

### 9.1.6 Necessary Documentation

For testing and troubleshooting command execution, the following documentation should be available at each station Processor:

- Copy of the ladder-diagram program in the station Processor.
- Completed forms giving the following information:
  - Communication Adapter Module switch settings
  - Listing of commands sent by the station
  - Listing of commands received by the station

A ladder-diagram printout can be generated using a compatible data terminal, such as a teletype or other line printer.

Forms for programmer documentation at each station are described in Section 10.

## 9.2 START-UP PROCEDURES

A careful start-up procedure is essential to proper Data Highway operation. With a methodical start-up procedure, cabling connections,

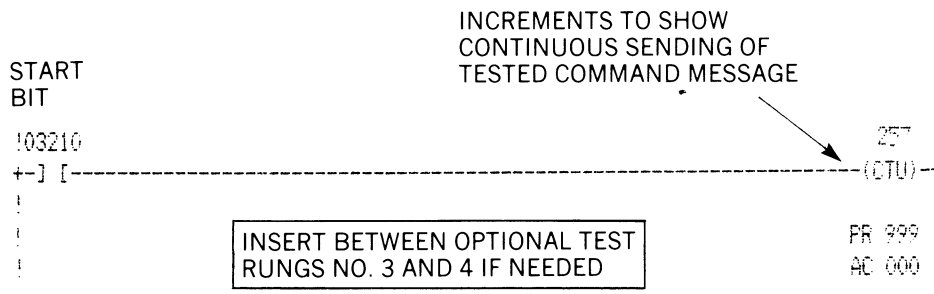


FIGURE 9-7 — Optional Test Counter



Module set-up, and support programming for Module communication can be tested at each station.

The start-up of a newly-installed Data Highway requires the combined efforts of maintenance personnel, the programmable controller programmer, and in many cases, the computer programmer. Because applications may vary widely, the recommendations of this Paragraph are general. Specific start-up procedures will depend on the exact nature of the individual application.

For the procedures of this Section, the following preparation is assumed:

- Station assembled using compatible components, as described in Section 2.
- Communication Adapter Module properly installed, as described in Section 3.
- The user programming at the station Processor includes the Communication Zone and the necessary support programming for initiating and monitoring user commands, as described in Sections 5 and 7.
- The user application program is fully tested.

This last point is **very** important. The testing of the user application program at each station is essential for proper operation. This means that the application program must be tested **before** the Data Highway is tested. The user must test his program which controls output devices, **including** testing of those parts of the program which use data transferred from other stations.

In a new installation, the user must complete all start-up procedures of the controller before attempting to test Data Highway operation. This includes complete testing of I/O devices, I/O wiring, and program sequencing. Procedures for start-up of a new controller are covered in other Publications. A listing of these Publications can be found in Section 1.

In many cases, Data Highway capability is added to an existing controller installation. Here, the application program may be only slightly modified to use data from other stations. However, **any** editing or change of the

program must be tested at the controller so that errors can be corrected **before** the program is put into full operation. Again, this testing is the responsibility of the user.

### 9.2.1 Overall Approach

In start-up testing, it is best to limit the number of things happening at one time. By carefully limiting the scope of start-up testing to a small number of variables, the source of a problem is more readily detected.

#### PAIRED TESTING

In the early stages of Data Highway testing, limit the group size of stations being tested. Initially, start-up testing is done with only 2 stations communicating at a time; all other stations are OFF. Then, after each station has been tested in this manner, the testing of more than 2 stations at a time can begin. Finally, after comprehensive testing of all stations, station Processors can be placed in the RUN mode for normal operation.

To begin, one station is selected as a starting point. For the purpose of this description, this station is termed Station A. Any station to which Station A sends a command can then be selected as Station B. The first testing is then carried out between Stations A and B, with all other station interface Modules disconnected. Each command from A to B is tested and monitored to verify proper operation. Then Station B is checked for any commands which it received from Station A and for any commands which it sends to Station A.

Once testing between these two Stations has been completed, Station B is disconnected and another station, Station C, is selected, again based on its being addressed by a command from Station A. Since Station A has already been tested for several functions, problems with Station C can be more readily located and corrected.

Paired testing continues in this manner until all commands programmed at Station A have been tested. Then, commands from Station B are tested with other stations. This procedure continues, with pairs of stations being tested each time until all commands sent on the Data Highway have been checked in this manner.

By following this procedure, the user tests each command for proper execution by the station interface Modules at each station. This testing also checks the support programming done at each station to initiate and monitor commands, including REMOTE/LOCAL FAULT monitoring.

The procedures of paragraphs 9.2.3 and 9.2.4 are used for paired testing of stations. For a station sending a command, carry out the procedures of paragraph 9.2.3. At the receiving station, carry out the procedures of paragraph 9.2.4.

### **INCREASING THE GROUP SIZE**

Once paired testing has been completed, the execution of each command has been verified. At this point, the size of the tested group of stations is increased and station interaction of this larger group can be monitored. For this phase of testing, the same checks outlined in paragraphs 9.2.3 and 9.2.4 can be made, but without the need to test each individual command. At this time, all station Processors remain in the TEST mode.

In this procedure, the user gradually increases the size of the tested group until all stations are communicating.

### **OPERATION**

Once the interaction of all station interface Modules has been checked, the station Processors can be put into operation, one at a time. The user must determine which controller he intends to put in the RUN mode initially, and in what order other stations are to be added in the RUN mode. Monitoring of station interaction can continue during these procedures.

By adding stations one at a time, the user can exercise maximum control over the application and monitor controller behavior carefully.

#### **9.2.2 Power-Up**

Only the 2 stations being examined in the first phase of start-up should be ON. Follow these steps in powering up each of these stations:

**Step 1** — Turn the Processor Mode Select Switch to PROGRAM LOAD position.

**Step 2** — Turn power ON at the station Processor. Observe Power Supply and Processor indicators for proper status.

**Step 3** — While observing the indicators of the Communication Adapter Module, turn the Mode Select Switch to TEST-MONITOR.

The PG indicator on the Module should turn ON briefly, then OFF. This indicates that the Module has checked the Communication Zone rungs of program. If this indicator remains ON, an error may have been detected in these rungs. Should this be the case, check the ERROR CODE storage word, as described in Step 4.

If this indicator does not turn ON, the Communication Zone of program may be incorrectly entered. Check this Zone if necessary.

The indicator labeled PR should be OFF. If this indicator is ON, check the Status Area control of the Module, as described in paragraph 2.2.1.

**Step 4** — If the PG indicator does not turn OFF after a few seconds, observe the ERROR CODE storage word.

The ERROR CODE storage word is listed in the Header Rung of the Communication Zone of program.

The significance of the ERROR CODE storage word is described in paragraph 9.1.4. Correct the Communication Zone rungs as indicated by the ERROR CODE. Then repeat Step 3, checking the status of the PG indicator.

When the indicators on the station Communication Adapter Module and its station Processor show normal operation for both stations being tested, perform the procedures of paragraphs 9.2.3 and 9.2.4.

#### **9.2.3 Testing the Sending Station**

Test the commands from each station using these procedures. After completing these steps for a command, verify data transfer at the receiving station, as outlined in paragraph 9.2.4.

The procedures outlined here can be used for any phase of start-up and troubleshooting testing, and at any time a Command rung is added

at a station Processor. During initial testing, only 2 stations have power ON and are connected to the Data Highway Cable for these procedures. In addition, both station Processors must be in TEST mode for initial start-up testing. During later phases of start-up testing, more than 2 stations may have power ON for these procedures.

There are 2 steps for testing of each command from a sending station:

**Step 1** — Set the START bit.

**Step 2** — Monitor the REMOTE and LOCAL FAULT bits.

Each of these steps is described in a subsequent paragraph.

### SETTING THE START BIT

The most direct way to control the START bit for test purposes is to duplicate the input conditions of the user program rung which latches this bit ON. If it is possible to do this easily during testing, duplicate these conditions and proceed to Step 2. However, because this may not always be practical, the set of optional test rungs, as described in paragraph 9.1.5, can be used. These rungs, entered at the end of the application program, can be controlled to test each command individually.

Sample test rungs are shown in Figure 9-6. The following steps outline the procedures for programming these rungs for testing. With the programming terminal connected, follow these procedures:

**Step 1** — Using the programming terminal, display the END (of program) statement.

**Step 2** — Turn the Processor Mode Select Switch to the PROGRAM LOAD position.

**Step 3** — Enter the test rungs in the format of Figure 9-6, using the following addresses:

- Rung No. 1 — Enter the address of an input switch for the EXAMINE ON instruction. (Paragraph 9.1.5 describes the selection of this switch.)
- Rung No. 2 — In the LATCH instruction, enter the START bit address for the command being monitored.

- Rung No. 3 — Enter the address of the DONE bit for the EXAMINE ON instruction. Enter the address of the START bit for the LATCH instruction.

Check that the format of these test rungs resembles that shown in Figure 9-6.

With these rungs entered, a command can now be initiated. To do this, perform the following steps:

**Step 4** — Turn the Processor Mode Select Switch to the TEST-MONITOR position.

**Step 5** — While observing the test rungs for status indication, turn the input switch ON.

The START bit is now LATCHED ON. Under normal operation this bit is being LATCHED and UNLATCHED as the Processor executes its scan, and the command is being sent continuously.

With the START bit energized in this fashion, proceed to the monitoring checks of the paragraph entitled "Monitoring REMOTE/LOCAL FAULT Bits." Once these checks have been completed, the next START/DONE bit addresses can be entered in the test rung for testing of the next command.

### MONITORING REMOTE/LOCAL FAULT BITS

This second step in command checking requires that the status indicator of the programming terminals be monitored for FAULT bits. To do this, the Bit Monitoring feature of the programming terminal can be used. (This feature is described in paragraph 9.1.2.)

Where the Bit Monitoring feature is not available, use the following steps to observe the instructions which examine the FAULT bits.

**Step 1** — Turn the Processor Mode Select Switch to TEST position.

**Step 2** — Use the SEARCH functions of the programming terminal to locate instructions which examine FAULT bits. (SEARCH functions are described in paragraph 9.1.2.)

**Step 3** — Observe the ON/OFF status indicator of the programming terminal for each FAULT bit corresponding to the command. (These ON/OFF status indicators are described in paragraph 9.1.2.)

Should the REMOTE or LOCAL FAULT bit be ON for the command sent, some hardware-related fault or programming error can be suspected. Check the connections and equipment indicated in Figure 9-4.

After checking a command in this manner, check the receiving station, as described in paragraph 9.2.4. Then, check any other commands as necessary, using the applicable procedures of paragraphs 9.2.2, 9.2.3, and 9.2.4.

#### **9.2.4 Testing the Receiving Station**

The receiving station is checked with the sending station for one purpose — verification of data transfer. Although this procedure may be time-consuming, it is essential in initial start-up testing and for testing whenever a command is added at a station.

The function of the station Communication Adapter Module upon receiving a command message is to execute the command at its station Processor and to format and transmit a reply message back to the sending station. Proper execution of this procedure is indicated by the START/DONE and REMOTE/LOCAL FAULT bits.

The checks performed in testing the sending station, therefore, can indicate and help to isolate the source of a problem which prevents the command from being executed. The checks at the receiving station help to verify that program addressing and Station No. switch selection is correct and that data is being sent to the intended station.

When a command has been initiated and tested at its sending station, perform the following procedures at the receiving station:

**Step 1** — On the programming terminal at that station, display the instructions for the application program which are affected by data transferred from the sending station.

To identify areas of the program which are affected by transferred data, refer to Form No. 5033, which is recommended programmer documentation for each station.

**Step 2** — Observe that the data at these locations matches the data in the proper locations

at the sending station Processor. For Write or Read commands, observe instructions which address transferred words in the program at the receiving station Processor. (These instructions include GET, PUT, TON, TOF, RTO, CTU, and CTD.)

For Bit Write commands, display the Bit Monitoring format or use the SEARCH functions to observe the ON/OFF status indicator for instructions which examine those bits in the program.

### **9.3 TROUBLESHOOTING**

The same tools and procedures used in start-up of a station containing a Communication Adapter Module can be used for troubleshooting. This Paragraph outlines procedures which can be used in addition to the start-up procedures of Paragraph 9.2.

#### **9.3.1 REMOTE/LOCAL FAULT Indicator ON**

As recommended in Section 7, some indicator must be controlled by the status of the REMOTE and LOCAL FAULT bits at each station Processor. Should this indicator go ON, connect and initialize a programming terminal and follow these procedures to isolate the source of the fault condition: (The steps of this procedure are outlined in the example of Figure 9-8.)

**Step 1** — Using the SEARCH functions, display the rung of program which controls the external FAULT indicator device. Determine whether a Status bit indicates that either a REMOTE or LOCAL FAULT bit is set ON.

**Step 2** — Using the SEARCH functions, display the rung of program which examines either the REMOTE or the LOCAL FAULT bits and controls a status bit or bits based on FAULT bit states.

**Step 3** — Examine each element of the rung which may have been set ON, causing the FAULT indicator to be energized.

When the rungs recommended in Figure 7-7 are used, observe each EXAMINE OFF condition. Should the status indication of the programming terminal show an EXAMINE OFF instruction as FALSE (not intensified), this means that the addressed bit is ON.

**STEP 1 — SEARCH OUTPUT ADDRESS**

KEY SEQUENCE:[SEARCH] [-<L>-] [0] [1] [0] [0] [0]

**DISPLAY**

|                        |  |                     |
|------------------------|--|---------------------|
| LOCAL FAULT<br>STATUS  |  | OUTPUT<br>INDICATOR |
| !05500                 |  | 01000 !             |
| +]/[--+                |  | (L)---+             |
| !                      |  | OFF !               |
| !05501!                |  | !                   |
| +]/[--+                |  | !                   |
| REMOTE FAULT<br>STATUS |  |                     |

INSTRUCTION INTENSIFIED  
THUS, LOCAL FAULT STATUS BIT,  
05500, IS OFF.

**STEP 2 — SEARCH LOCAL FAULT BIT MONITORING RUNG**

KEY SEQUENCE:[SEARCH] [-< )>-] [0] [5] [5] [0] [0]

**DISPLAY**

|                                                    |  |                       |
|----------------------------------------------------|--|-----------------------|
|                                                    |  | LOCAL FAULT<br>STATUS |
| !03200 03201 03202 03203 03204 03205 03206 03207   |  | 05500 !               |
| +]/[---]/[---]/[---]/[---]/[---]/[---]/[---]/[---] |  | ( )---+               |
| !                                                  |  | !                     |

INSTRUCTION NORMAL INTENSITY. THUS  
THIS BIT IS ON.

IF BIT MONITORING IS AVAILABLE, DISPLAY REMOTE/LOCAL  
FAULT STATUS WORD TO EXAMINE FAULT BIT STATUS.

**STEP 3 — LOCATE ANY FAULT BITS ON IN THIS RUNG. HERE,  
BIT 03202 IS ON.**

**STEP 4 — IDENTIFY START BIT FOR THIS FAULT BIT. FOR  
LOCAL FAULT BIT 03202, THE START BIT IS BIT 03112.**

**STEP 5 — SEARCH THE START BIT EXAMINE INSTRUCTION.**

KEY SEQUENCE:[SEARCH] [-I I-] [0] [3] [1] [1] [2]

**DISPLAY**

|                                 |                 |         |
|---------------------------------|-----------------|---------|
| START<br>BIT                    | COMMAND<br>CODE |         |
| !03112 02300 052 020 022        |                 | 37707 ! |
| +]/[---] [---[G]---[G]---[G]--- |                 | ( )---+ |
| !                               | 000 000 000     | !       |

**STEP 6 — DETERMINE AREA OF HARDWARE-RELATED PROBLEM.  
HERE, THE COMMAND CODE IDENTIFIES STATION NO. 023.  
CONCLUSION: LOCAL FAULT BETWEEN LOCAL STATION AND  
REMOTE STATION WITH STATION NO. 023.**

**FIGURE 9-8 — REMOTE/LOCAL FAULT Troubleshooting Example**

**Step 4** — From the results of Step 3, determine the START bit address for the corresponding command.

The START bit has a strictly defined correspondence to a REMOTE or LOCAL FAULT bit. Figure 6-2 shows this relationship.

**Step 5** — Use the SEARCH functions to locate the Command rung which begins with the START bit, as determined in the previous step.

**Step 6** — Examine the Command Code of this rung to determine the remote Station No. to which the command was sent.

**Step 7** — Determine the nature of the faulted condition and correct this condition.

Use Figure 9-4 as a guide to tracing possible sources of a faulted condition. The ERROR CODES listed in Table 9-3, may also be used. These codes are displayed in the ERROR CODE storage word. (Refer to Figure 9-5.)

### 9.3.2 Module Replacement

After other troubleshooting checks have been made, it may be necessary to replace the Communication Adapter Module.

#### REMOVING THE MODULE

**Step 1** — Turn power to the Module OFF.

This power is provided by the Power Supply which connects to the PLC Processor. On most PLC Processors an Interlock Bar or Switch is provided to turn this power OFF.

**Step 2** — Disconnect all cables connected to Module sockets.

**Step 3** — Lift up the plastic lever on the Module to break its backplane connection.

**Step 4** — Firmly grasp the sides of the Module and pull it gently from the Processor Chassis slot.

#### INSTALLING THE REPLACEMENT MODULE

**Step 1** — Set Module switches to match the switch settings of the replaced Module. Replace the switch cover when this is completed.

**Step 2** — Insert the replacement Module in the Processor Chassis. Reconnect the cables to Module sockets.

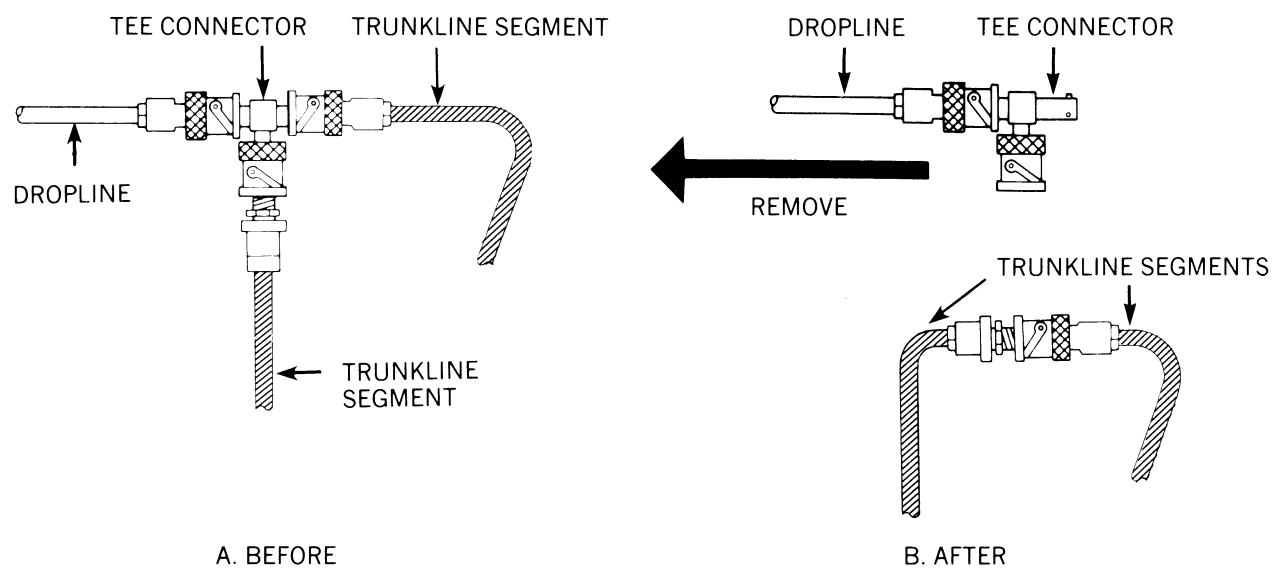
Module power-up is described in paragraph 9.2.2.

### 9.3.3 Station Disconnection

For most troubleshooting and start-up purposes, a station can be disconnected from the Data Highway communication link simply by disconnecting the station dropline from Socket A or B of the Communication Adapter Module. However, should a station be disconnected for an extended period of time, or should a dropline no longer be needed at any point along the Data Highway Cable, the station should be disconnected at the tee connector.

To disconnect a station at this point, first disconnect the station dropline from the tee connector. Then remove the male and female trunkline cable connections to the tee and connect these cable connectors together. The tee connector can be used at some other point in the Data Highway trunkline cable, as necessary.

Figure 9-9 illustrates station disconnection.



**FIGURE 9-9 — Disconnecting a Station**

## Section 10

### DESIGN AIDS AND DOCUMENTATION

#### 10.0 GENERAL

This Section provides aids to the programmer, to help in the writing, organization, and documentation of his program for Communication Adapter Module operation.

#### 10.1 PROGRAM SUMMARY

Figure 10-1 is a sample program which incorporates both a Communication Zone and the support programming recommended for the single command programmed in this Zone.

The rungs used in this example illustrate the programming principles of Sections 5 through 7 of this Manual. Of course, user application programming may vary widely from this example. In any case, certain types of support programming should be used in any program for a command at a station. Necessary support programming for each command includes:

- START bit LATCH and UNLATCH control
- REMOTE/LOCAL FAULT bit monitoring

Each of these parts of the program is shown in Figure 10-1.

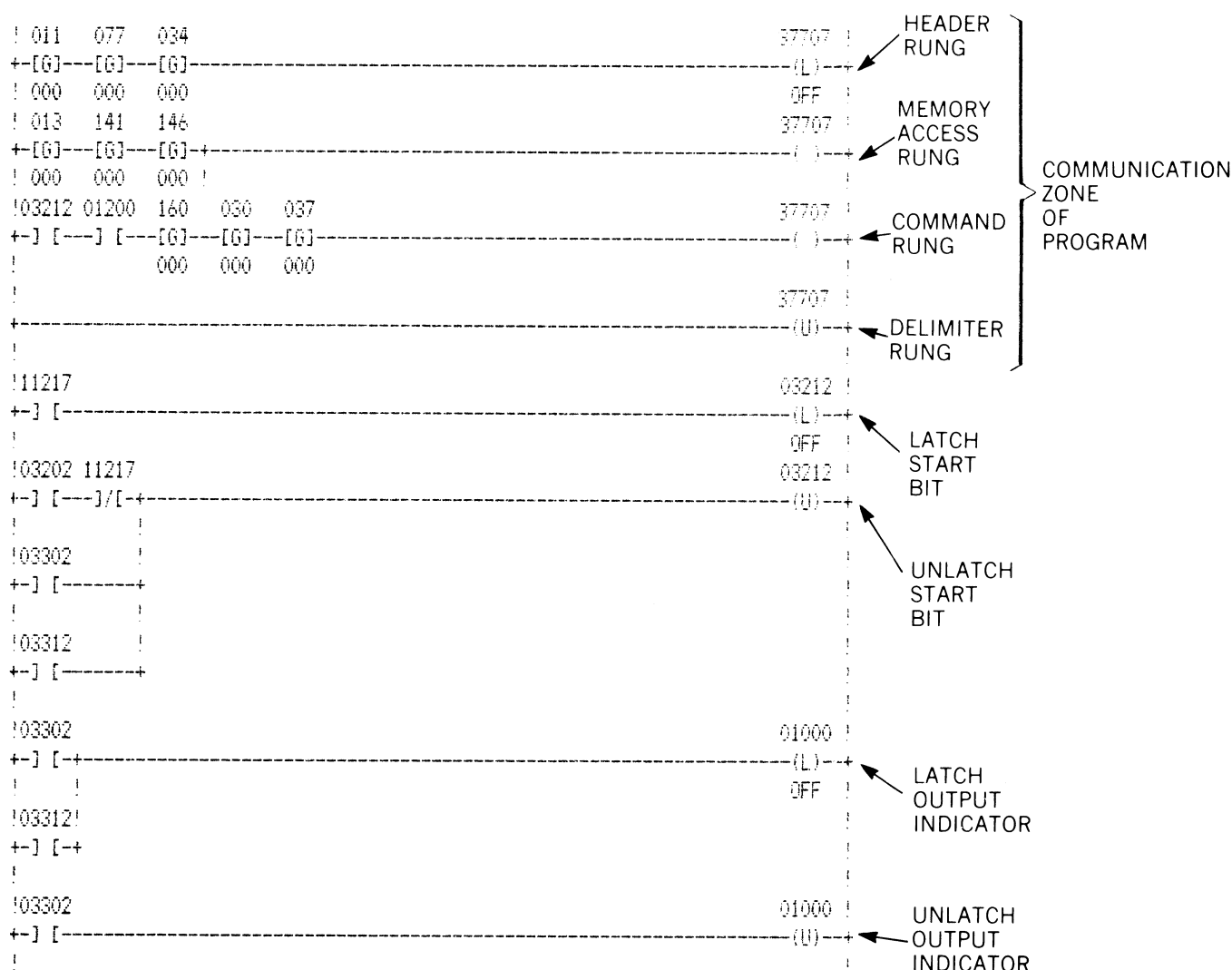


FIGURE 10-1 — Sample Program



## 10.2 FORMS

The following Forms are available for programmer documentation:

- Switch Settings — Communication Adapter Module (Cat. No. 1774-KA), Form No. 5031
- Command Listing — From Station, Form No. 5032
- Command Listing — To Station, Form No. 5033

A copy of each of these Forms should be a part of the standard documentation at each station which contains a Programmable Controller.

These Forms are available in quantity through Catalog Services, Allen-Bradley Co., Milwaukee, Wisconsin.

## 10.3 MEMORY MAPS

For quick reference, a map of the memory organization for each Bulletin 1772 and 1774 Programmable Controller is included here. These maps should be used in conjunction with the recommendations of Section 4, concerning Communication Adapter Module access to memory areas.

Figures 10-2 through 10-6 show the memory organization for each Controller.

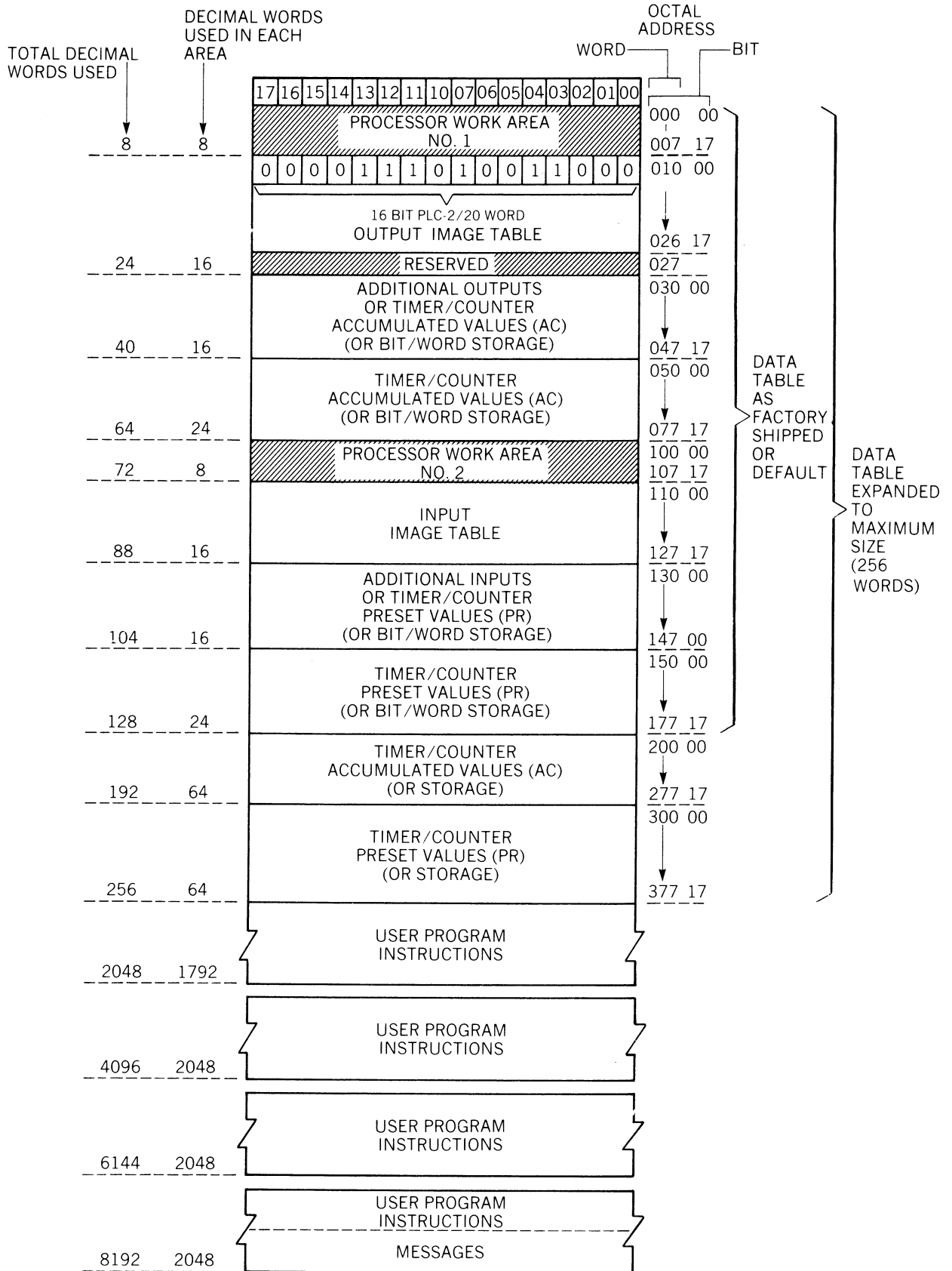


FIGURE 10-2 — PLC-2/20 Processor Memory Organization (Mapped)

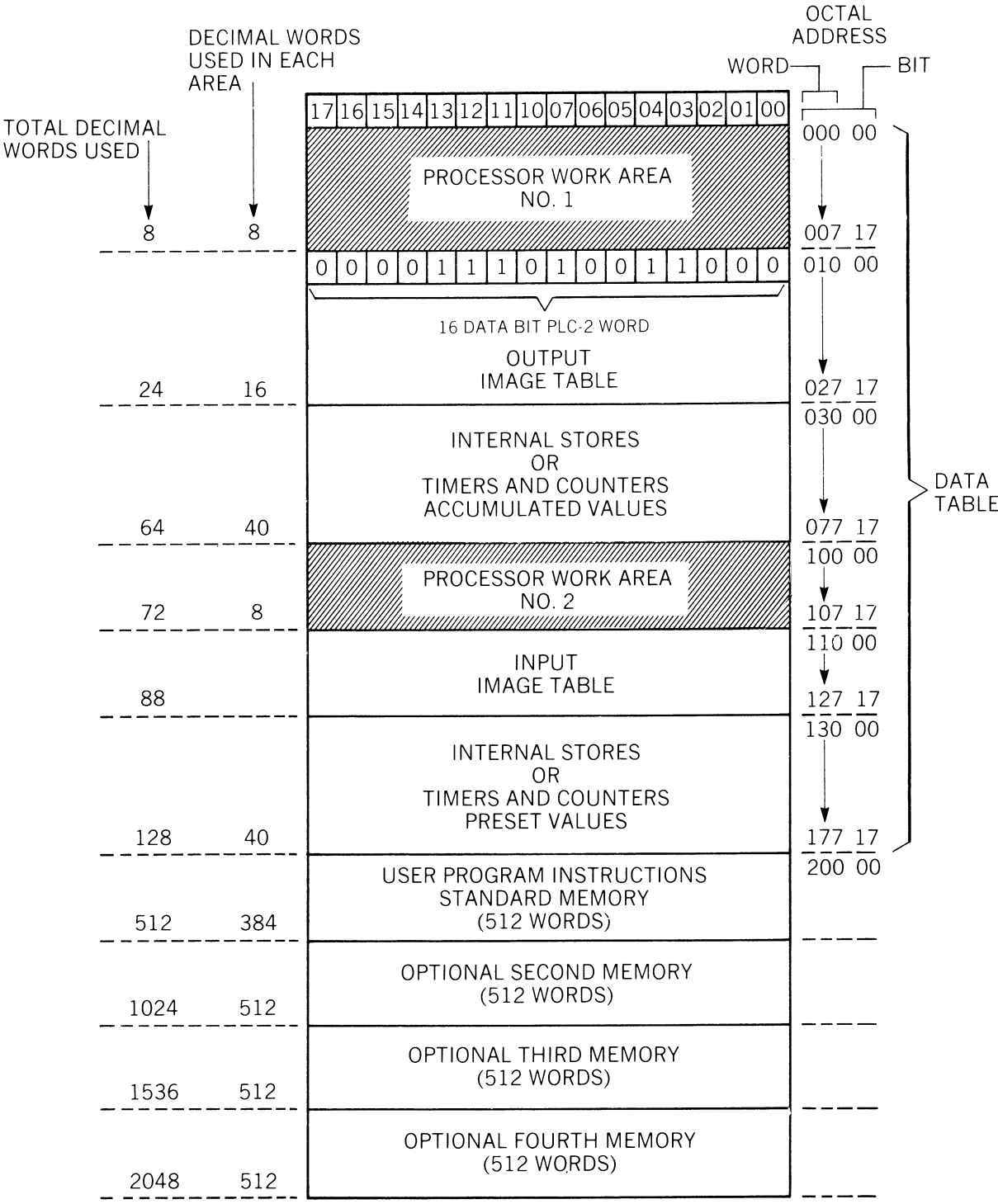


FIGURE 10-3 — PLC-2, Series A Processor Memory Organization (Mapped)

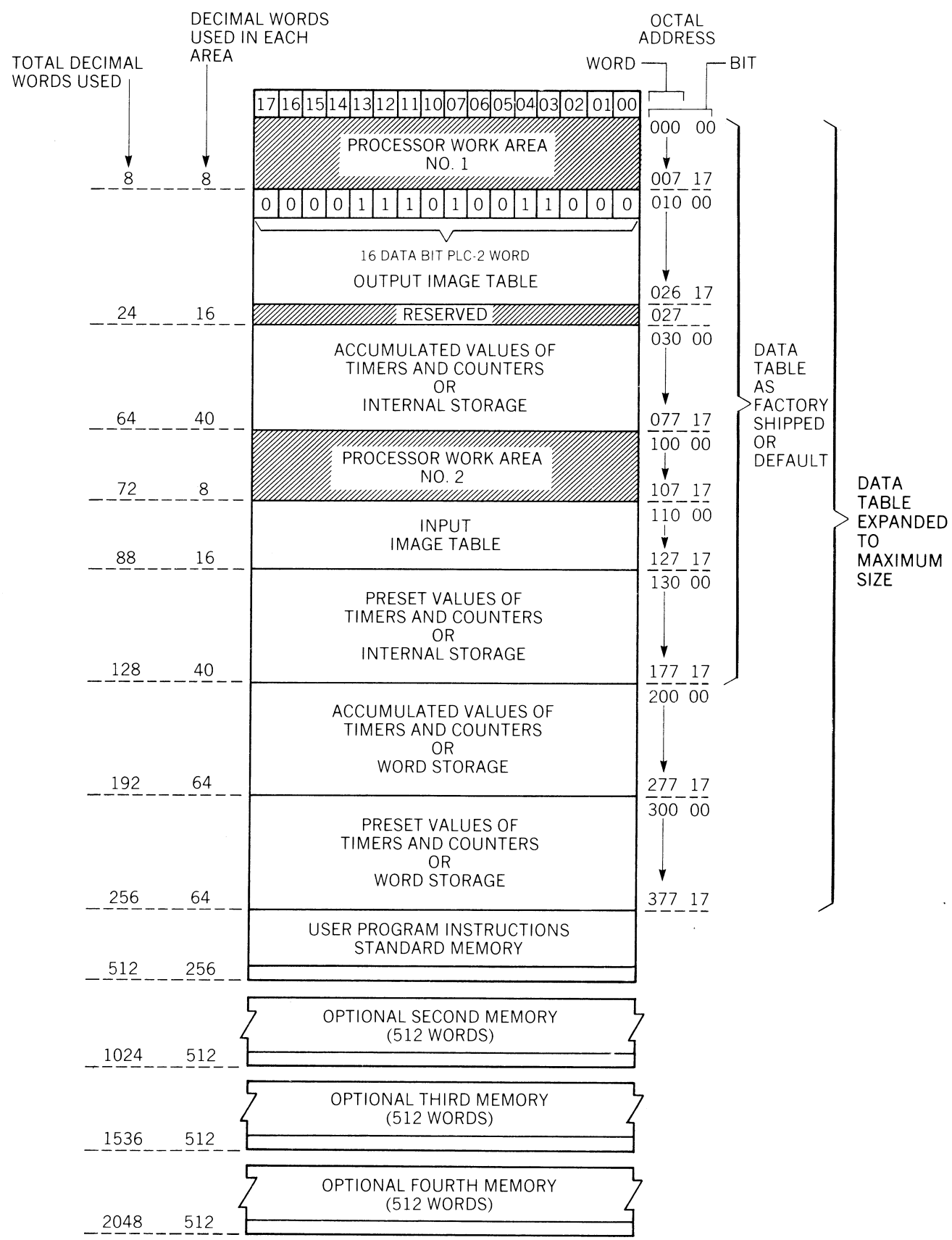


FIGURE 10-4 — PLC-2, Series B Processor Memory Organization (Mapped)

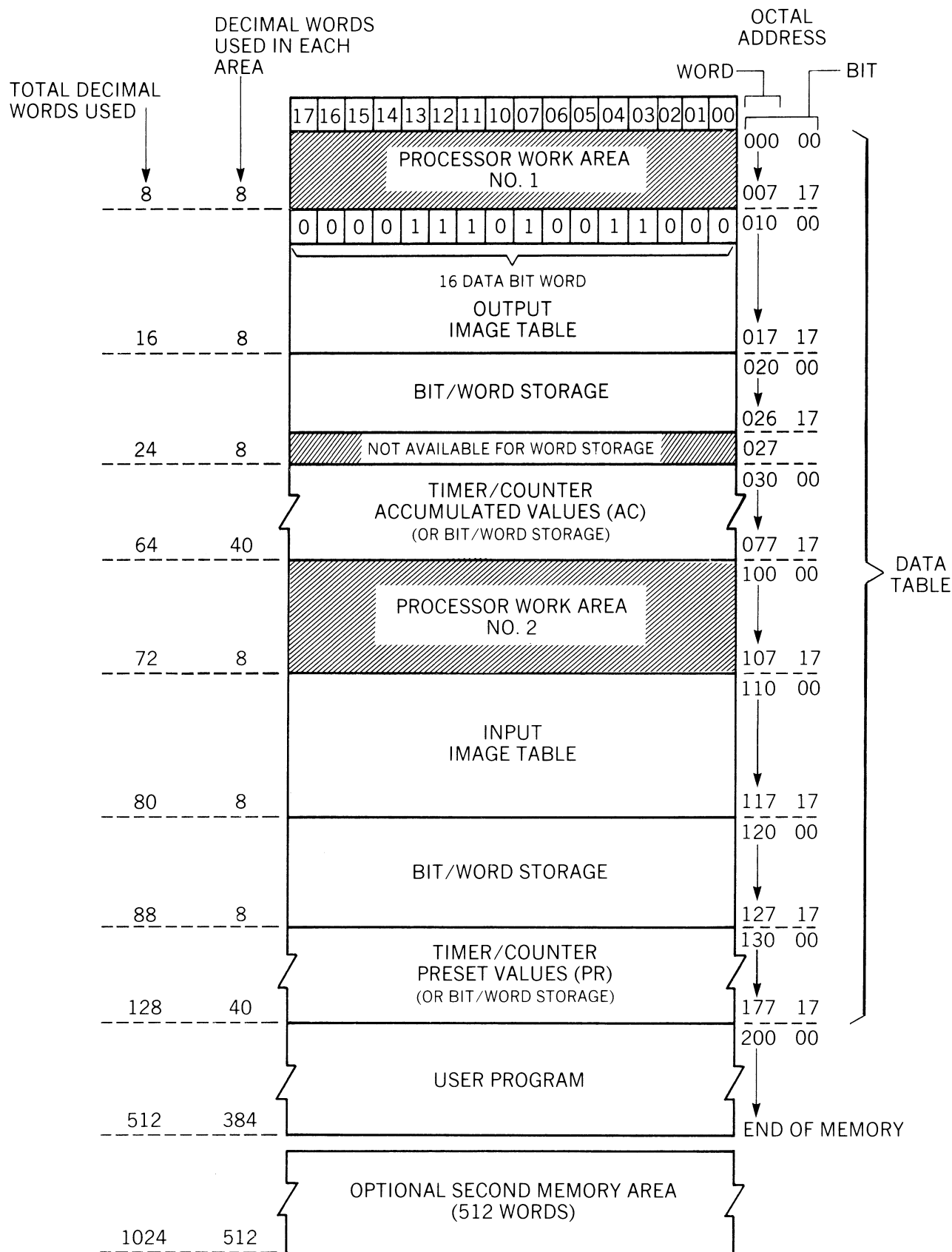


FIGURE 10-5 — Mini-PLC-2 Processor Memory Organization (Mapped)

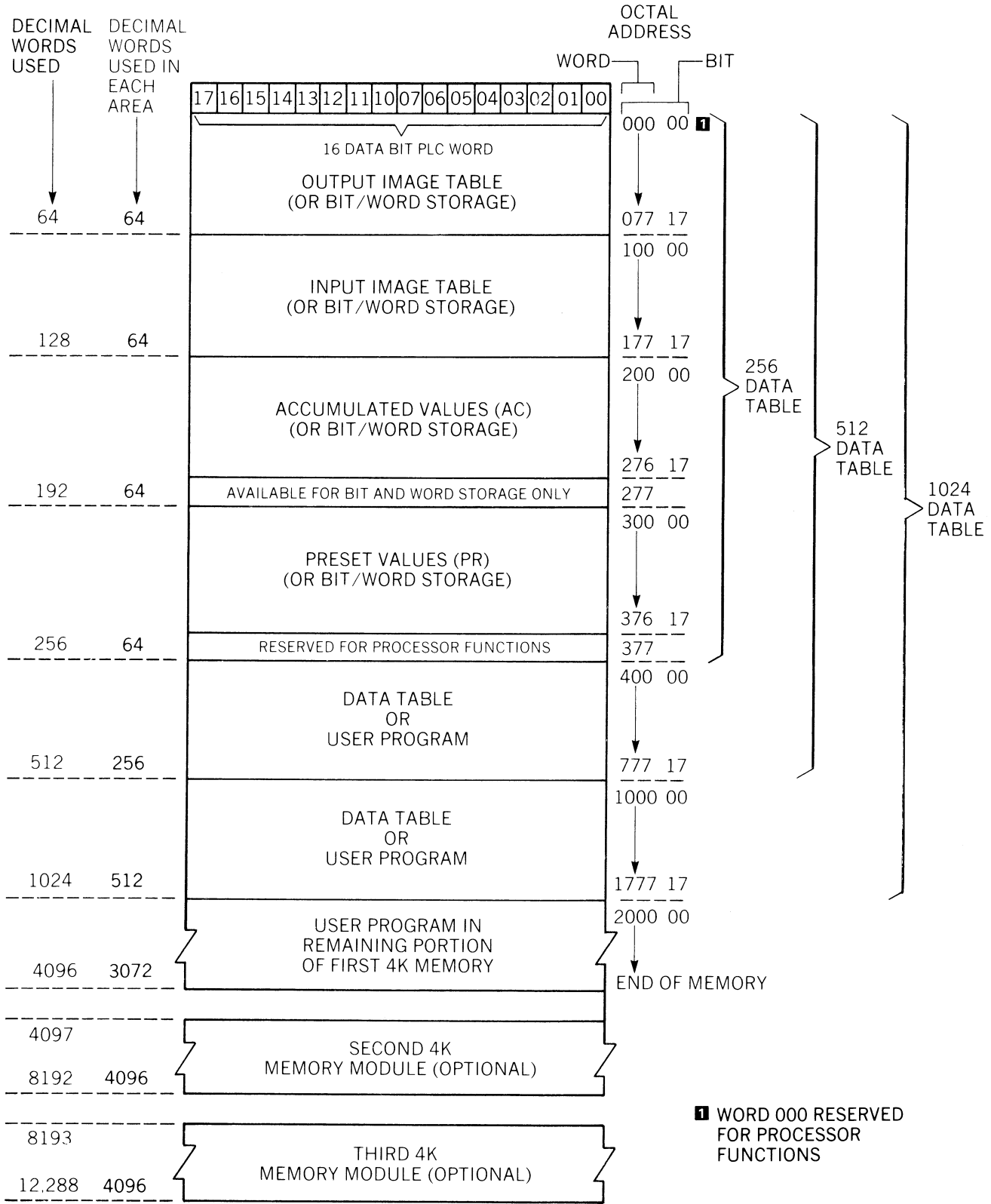


FIGURE 10-6 — PLC Processor Memory Organization



**ALLEN-BRADLEY**  
Cleveland, Ohio 44143

DATE: \_\_\_\_\_  
BY: \_\_\_\_\_

ALLEN-BRADLEY DATA HIGHWAY  
**SWITCH SETTINGS**  
**COMMUNICATION ADAPTER MODULE**  
**CAT. NO. 1774-KA**

(Publication 5031 — October, 1980)

STATION NO. \_\_\_\_\_

NO. 2 — RECEIVE  
UNPROTECTED COMMANDS  
• ON - ENABLED  
• OFF - DISABLED

NO. 5 — SEND  
UNPROTECTED COMMANDS  
• ON - ENABLED  
• OFF - DISABLED

NO. 1 — RECEIVE  
PROTECTED COMMANDS  
• ON - ENABLED  
• OFF - DISABLED

**INSTRUCTIONS:** USE A PENCIL TO  
DARKEN SWITCHES TO SHOW PROPER  
SETTINGS, AS SHOWN. KEEP THIS  
FORM WHERE IT CAN BE EASILY  
REFERENCED.

**EXAMPLE:**



(A)

|     | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
|-----|---|---|---|---|---|---|---|---|
| ON  |   |   |   |   |   |   |   |   |
| OFF |   |   |   |   |   |   |   |   |

NO. 3 — NOT USED  
MAY BE ON OR OFF

NO. 6, 7, 8  
UNUSED  
(ANY SETTING)

NO. 4 — RECEIVE  
PRIVILEGED WRITE  
• ON - ENABLED  
• OFF - DISABLED

(C)

|     | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
|-----|---|---|---|---|---|---|---|---|
| ON  |   |   |   |   |   |   |   |   |
| OFF |   |   |   |   |   |   |   |   |

| STATION NO. |   |   |              |   |   |             |   |   |
|-------------|---|---|--------------|---|---|-------------|---|---|
| FIRST DIGIT |   |   | SECOND DIGIT |   |   | THIRD DIGIT |   |   |
| ON          | 2 | 1 | 4            | 2 | 1 | 4           | 2 | 1 |
| OFF         | 0 | 0 | 0            | 0 | 0 | 0           | 0 | 0 |

WORD SELECT  
SWITCHES  
NO. 1 AND 2

NO. 3 — STATUS AREA  
INHIBIT SWITCH

(D)

|     | 1 | 2 | 3 | 4 |
|-----|---|---|---|---|
| ON  |   |   |   |   |
| OFF |   |   |   |   |

NO. 4 —  
UNUSED  
(ANY SETTING)

NO. 3 — OUTPUT  
STATE SWITCH

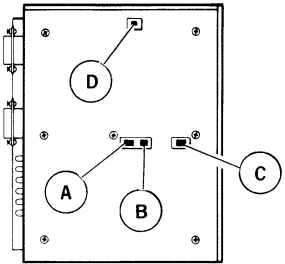
(B)

|     | 1 | 2 | 3 | 4 |
|-----|---|---|---|---|
| ON  |   |   |   |   |
| OFF |   |   |   |   |

NO. 1, 2  
DATA HIGHWAY  
BAUD RATE — BOTH  
ON FOR 57.6K  
BAUD

NO. 4 — UNUSED  
(ANY SETTING)

**SWITCH LOCATIONS**



**FIGURE 10-7 — Sample Form (Publication 5031) for Switch Settings  
on Communication Adapter Module (Cat. No. 1774-KA)**

DATE: \_\_\_\_\_  
BY: \_\_\_\_\_

ALLEN-BRADLEY DATA HIGHWAY  
**COMMAND LISTING — FROM STATION**  
(Publication 5032 — October, 1980)

STATION NO. \_\_\_\_\_

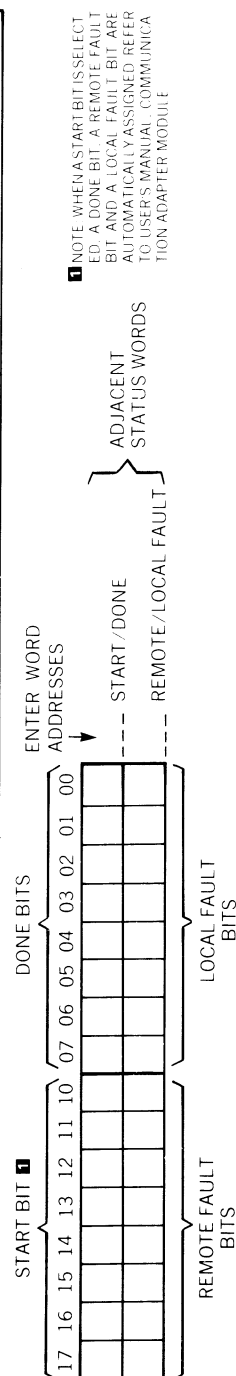
**EXAMPLE:**

| START BITS | COMMAND TYPE | PRIORITY NORMAL | REMOTE STATION NO. ADDRESSED | AREAS CONTROLLED |                   | COMMENTS    |
|------------|--------------|-----------------|------------------------------|------------------|-------------------|-------------|
|            |              |                 |                              | AT LOCAL STATION | AT REMOTE STATION |             |
| 04010      | WRITE        | N               | 022                          | 060-062          | 051-053           | PARTS COUNT |

**COMMANDS  
AT THIS  
STATION**  
(ENTER  
INFORMATION  
AS SHOWN)

[illegible]

**STATUS WORDS**  
(DARKEN USED  
BITS FOR QUICK  
REFERENCE.)



**FIGURE 10-8 — Sample Form (Publication 5032) for Command Listing — From Station**



DATE: \_\_\_\_\_  
BY: \_\_\_\_\_

(Publication 5033 — October, 1980)

DIRECTIONS: USE THIS FORM TO DOCUMENT COMMANDS RECEIVED AT THIS STATION FROM OTHER STATIONS.

| REMOTE STATION<br>SENDING COMMAND<br>STATION NO. | COMMAND TYPE | DATA WRITTEN<br>TO ADDRESS(ES) | COMMENTS            |
|--------------------------------------------------|--------------|--------------------------------|---------------------|
| <i>O/O</i>                                       | <i>WRITE</i> | <i>023-025</i>                 | <i>TEMP. VALUES</i> |

[illegible]

**FIGURE 10-9 — Sample Form (Publication 5033) for Command Listing — To Station**

